Effect of Date of Sowing and Combination of Nitrogen, Phosphorus and Potassium on the Growth and Yield of Sea Island Cotton (*Gossypium barbadense* Linn.)*

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Introduction

In Kerala, cultivation of Sea Island cotton is confined mostly to the District of Palghat. In view of the increasing demand for the extra long staple cotton, it was considered desirable to try the performance of this crop in other Districts also. Accordingly preliminary investigations were carried out at the Agricultural College and Research Institute, Vellayani, during 1959-62 to study the performance of the crop in that locality. The crop was sown in the month of July in all these years. Though the vegetative growth and flowering of the crop were observed to be quite satisfactory, excessive precipitation during the month of October coincided with flowering of the crop which resulted in heavy shedding of squares and flowers with consequent reduction in the yield of '*Kapas*' (seed cotton). This failure of the crop could be attributed only to the unfavourable date of sowing followed in all these years Hence the present investigation was undertaken to find out the most favourable sowing date that would provide the crop with the optimum climatic conditions during the season of its growth, especially at the time of flowering and boll bursting. This work also envisaged the study of the fertiliser requirements of the crop for this region.

Review of literature

It has been reported by several workers that the yielding capacity and other economic characters of cotton are subject to considerable variation depending upon environment.

Christidis and Harrison (1955) stated that early—sown cotton might be able to develop a larger number of fair sized bolls. Similar results were also obtained by Bederkar *et al.* (1958) and Dustur (1959) who observed vigorous growth of plants as a result of early sowing. With regard to the effect of nutrients, Bederker and Shaligram (1959) reported that a combination of nitrogen and phosphorus gave an increased number of flowers. Dustur (1959)

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obtained the maximum growth of plants by a combined application of the three major plant nutrients.

Joshi *et al* (1941) reported that high temperature caused heavy shedding of squares, flowers and bolls. According to Christidis and Harrison (1955). lack of excess of moisture in the soil tended to increase shedding. Shaligram (1958) found no definite pattern of shedding as influenced by nitrogen or phosphorus. Nelson and Ware (1932) reported that shedding percentage was not affected by the application of potash.

Qureshi (1957) observed that a season of well distributed rainfall, high humidity and low temperature resulted in increased ginning percentage. However, Bederkar *et al.* (1958) found that ginning percentage was not affected by date of sowing. Similar results were also reported by Ramachandran *et al* (1959)

Christidis and Harrison (1955) reported that ginning percentage was not affected by nitrogen supply, while phosphorus had only very little effect. Manurial trials conducted by Ramaswamy and Bhatt (1957) on Sea Island cotton also indicated that fertilisers had no response on this character.

Varying results have been reported by several workers for the effect of time of sowing and fertilisers on the fibre properties. Sen and Kar (1947) observed increased fibre length due to low soil moisture during the period of flowering and boll formation. Deo (1955), Sivasubramoniam (1957) and Jambunathan (1959) also observed superior fibre qualities in the carlier-sown crop. However, Afzal (1943) got adverse results on the fibre properties by early sowing. As observed by Iyengar (1941), Sen and Ahmed (1947) and Deo (1956), different levels of fertiliser combinations did not show any significant response on the fibre characters.

Vaidya (1953), Christidis and Harrison (1955), Sivasubramoniam (1957), Nayak (1956), Bederker *et al* (1956) and lyengar (1960) obtained higher yields by early sowing.

With regard to the application of fertilisers, Panse (1953) and Bederkar *et al* (1957) reported that application of phosphorus alone had no effect on the yield. Nelson (1949) reported the optimum doses of N, P_2O_5 and K_2O as 60, 50 and 60 lbs, respectively, per acre, while Ramaswamy and Bhatt (1957) obtained results indicating these to be 60, 30 and 50 lbs respectively. Dastur (1959) found that these three nutrients were removed from the soil in a definite ratio of 3.3 : 1 : 3.3.

Materials and methods

The experiment was laid out on the dryland area of the Agricultural College Farm, Vellayani. Sea Island cotton 'Andrews' belonging to the species *Gossypium barbadense* was used in the study.

Four dates of sowing were selected so that the plants could come up to flowering in the more favourable period of August-September. The dates fixed were at intervals of 15 days from the date of first sowing immediately after the pre-monsoon showers. The four dates were as follows:

D_1 .. 16-4-1962 .. First sowing
D_2 .. 2-5-1962 .. Second sowing
D_3 .. 18–5–1962 .. Third sowing
D_4 .. 3-6-1962 .. Fourth sowing

The following three levels of fertilisers were tried.

M_1 : 40 lbs N, 30 lbs P_2O_5 and 50 lbs K_2O

M_2 : 30 lbs N, 20 lbs P_2O_5 and 40 lbs K_2O (State recommended dose)

Ms : 50 lbs N, 40 lbs P_2O_5 and 60 lbs K_2O

A split plot design with the cultural treatments (date of sowing) as the main plot and fertiliser treatment as the sub plot was used in the study. The net plot size was 20′ x 10′, with the ridges and furrows 2½′ apart. Seeds were sown at a spacing of 1′ on the ridges. There were eighty plants in each plot. The experiment was conducted in five replications.

Results and discussion

1. *Effect of rainfall on shedding of squares, flowers and bolls and on the final yield of kapas.*

The data presented in Table I show that the high moisture conditions due to an increased precipitation has resulted in a greater percentage of shedding of squares, flowers and bolls, though the effect was not significant. This is in conformity with the results obtained by Growther (1934).

TABLE I

Effect of rainfall on shedding of squares, flowers and bolls and on the final yield of *Kapas*

Date of sowing	Rainfall (mm)		Shedding percentage	Final yield of *Kapas* (lbs/A)
	During flowering & boll formation	Total during the crop season		
D_1	670	1165	43.66	1111.95
D_2	872	1388	41.81	1184.25
D_3	652	1041	46,65	483.52
D_4	1364	1844	49.30	452.30

A greater shedding due to an increased precipitation could be attributed to the interruption of sunlight due to cloudy sky which might have resulted in a reduction in the rate of carbohydrate synthesis by the plant The direct effect of rain drops might have also played a role in increasing shedding.

The lowest yield recorded in D_4 which received the maximum rainfall was mainly due to the highest percentage of shedding which occurred as a result of heavy and well distributed showers throughout the flowering and boll formation stage. Similarly, increased yield obtained in D_2 must be attributed to the minimum shedding

which was significantly lower than that recorded in D_4. This result indicates that a high rainfall during flowering and boll formation period may result in poor yield of cotton with its adverse effect on shedding.

2. *Effect of date of sowing and fertiliser treatments on plant characters and yield attributes*

Effect of date of sowing and level of fertilisers on the yield attributes, such as, height of plant, earliness in flowering and maturity, shedding percentage and number of flowers produced per plant, has been studied and the data are presented in Table II.

(i) *Height of plant at maturity*

Significantly higher increases in the height of plants have been observed for sowing dates D_1 and D_2. Similarly, the height of plants has been significantly higher for a fertilizer application of 50 lbs

TABLE II

Effect of date of sowing and fertiliser levels on the growth and yield characters of Sea-Island cotton

Growth and yield character	Fertiliser level	Date of sowing D 1	D 2	D 3	D 4	Mean
Height of plant at maturity (cm)	M_1	104.80	129.40	100.40	82.00	104.15
	M_2	100.80	123.40	97.80	77.20	99.80
	M_3	106.00	135.60	102.80	85.20	107.40
	Mean	103.87	129.47	100.33	81.47	103.78
Earliness in flowering (Number of days taken for the first flower opening)	M_1	67.40	65.80	66.60	62.60	65.60
	M_2	66.60	67.40	67.40	60.30	65.40
	M_3	65.80	66.00	66.20	64.00	65.50
	Mean	66.50	66.40	66.70	62.60	65.50
Earliness in maturity (Bartlett's Index values)	M_1	0.6769	0.5908	0.5716	0.6160	0.6138
	M_2	0.5710	0.5568	0.5392	0.6588	0.5815
	M_3	0.6408	0.6210	0.6126	0.5794	0 6135
	Mean	0.6295	0.5895	0.5745	0.6181	0.6029
Shedding of squares, flowers and bolls (percent)	M_1	44.252	38.612	47.302	51.952	45.530
	M_2	43.520	43.550	47.662	49.998	46.183
	M_3	43.152	43.374	50.976	45.956	45.840
	Mean	43.641	41.812	48.647	49.302	45.851

Table II Continued

Number of flowers per plant	M_1	91.80	87.80	60.80	36.60	69.25
	M_2	87.60	71.80	48.80	26.40	58 65
	M_3	88.80	88.00	60.60	30.20	66.90
	Mean	89.40	82.53	56.73	31.07	64.93
Number of matured bolls per plant	M_1	46·80	53.60	25.60	14.00	35.00
	M_2	46.20	37.60	22.00	10.80	29.15
	M_3	27.20	46.60	25.80	13.60	33.30
	Mean	46.73	45.93	24.47	12.80	32.48
Yield of *Kapas* (lbs/plot)	M_1	5.940	5.734	2.414	2.238	4.081
	M_2	3.964	4.440	2.006	2.104	3.129
	M_3	5.412	6.140	2.236	1.870	3.915
	Mean	5.105	5.438	2.219	2.071	3.708

Critical difference (5 percent level)	Date of sowing	Fertiliser levels
Height of plants	1.64	1.73
Earliness in flowering	1.48	0.41
Earliness in maturity	0.0296	0.0225
Shedding percentage	2.179	3.324
Number of flowers	7.84	5.61
Number of bolls	4.14	12.66
Yield of *kapas*	1.717	0.55

N, 40 lbs P_2O_5 and 60 lbs K_2O per acre. This is in agreement with the results obtained by Dastur (1959).

(ii) *Earliness in flowering and maturity*

Earliness was determined by the number of days taken for the first flower opening and by the Bartlett's Index.

The fourth date of sowing recorded significant earliness in flowering. The earlier sowing dates are almost similar in their effects on the first flower opening. However, Bartlett's Index indicate that D_1 followed by D_4 matured earlier, though there is no significant difference between them.

The earliness in flowering and in maturity of the late sown crop (D_4) was due to the shortened vegetative and reproductive phases as compared to the longer periods which were available for the early-sown crop. The D_1 crop also matured as early as the crop sown on D_4. This could have been due to the inadequate soil moisture conditions which prevailed as a result ofonly very low rainfall received by this crop after flowering. Significant earliness in maturity was obtained for a fertiliser treatment of 40 lbs N, 30 lbs P_2O_5 and 50 lbs. K_2O.

(iii) *Shedding of squares, flowers and bolls*

The highest percentage of shedding recorded for D_4 could be attributed to the maximum rainfall which occurred during the flowering and boll formation stage of this crop.

(iv) *Number of flowers and bolls*

The two earlier sowings recorded a larger number of bolls than the two later sowings. The increased number of flowers recorded for D_1 and D_2 sowings might have been due to the maximum height the plants attained by early sowings. As the plant height increased the number of sympodial branches also increased, which resulted in more flowers.

(v) *Yield of kapas.*

Early sowing had a significant effect in increasing the yield of *kapas.* The NPK level M_1 gave significantly higher yield than that recorded for M_2 though the difference between M_1 and M_3 was not significant. Earlier trials (Anon., 1956) have revealed that 40 lbs nitrogen in combination with P_2O_5 and K_2O result in higher yield in Sea Island Cotton. In the present study, too, it is observed that the NPK combination of 40 lbs N, 30 lbs P_2O_5 and 50 lbs K_2O per acre is better for the Vellayani region. Ramaswamy and Bhatt (1957) found that a rate of 60 lbs N per acre was more suitable for this crop. The differences in the response to nitrogen might be due to the differences in soil conditions. Interaction studies revealed that early sowing in the first week of May with fertiliser doses of 40 lbs N, 30 lbs P_2O_5 and 50 lbs K_2O per acre was superior to all the fertiliser combinations tried for the later crops.

3. *Effect of date of sowing and fertiliser treatment on the fibre characters*

The fibre characters determine the quality and market value of the cotton lint. Though they are largely influenced by variety they are also reported to be influenced by environmental conditions and fertiliser treatment.

The results obtained in the present investigation are summarised in Table III.

TABLE III

Effect of date of sowing and fertiliser levels on fibre characters

Fibre character	Fertiliser level	Date of sowing				Mean
		D_1	D_2	D_3	D_4	
Fibre length (in.)	M_1	1.2820	1.3520	1.2660	1.2580	1.2895
	M_2	1.2840	1.3420	1.2460	1.2540	1.2815
	M_3	1.2940	1.3400	1.2740	1.2600	1.2920
	Mean	1.2870	1.3450	1.2620	1.2570	1.2877

Table Ill-Continued

Fibre weight (10^{-6} oz. per in.)	M_1	0.1270	0.1274	0.1144	0.1160	0.1212
	M_2	0.1248	0.1194	0.1148	0.1152	0.1186
	M_0	0.1268	0.1216	0.1180	0,1140	0.1201
	Mean	0.1262	0.1228	0.1157	0.1150	0.1199
Pressley strength (lbs per mg)	M_1	6.606	6.790	6.482	6.396	**6.569**
	M_2	6.496	6.482	6.414	6.526	6.480
	M_3	6.406	6.442	6.418	6.418	6 417
	Mean	6.503	6.571	6.433	6.447	6.489
Maturity co-efficient	M_1	08740	0.9290	0.8996	0.8606	0.8817
	M_2	0.8760	0.8970	0.8876	0.8570	0.8795
	M_3	0.8846	0.9040	0.8878	0.8622	0.8847
	Mean	0.8782	0.9011	0,8917	0.8567	0.8820

Critical difference (5 percent level)	Date of sowing	Fertiliser level
Fibre length	0.0209	0.0395
Fibre weight	0.0038	0.0026
Pressley strength	0.1960	0.8930
Maturity co-efficient	0.0198	0.0010

Earlier sowings (D_1 and D_2) recorded significantly longer fibres. Increased fibre weight was also obtained as a result of earlier sowings, while the pressley strength was not affected by date of sowing. The data on maturity coefficient revealed that D_2, D_3, and D_1 were significantly superior to D_4. The increased fibre length in D_1 and Da could be attributed to the well-distributed light showers received during the flowering and boll-formation period of this crop. A more favourable soil moisture condition due to the light showers during this stage might have increased the fibre length, since the formation of the primary wall of the cotton fibre is complete during a period of sixteen days after flowering. The decrease in fibre length recorded in the late sowings (D_3 and D_4) might have been due to excessive rainfall received during the flowering and boll-formation period. This resulted in a water-logged condition around the roots of the plants, which might have checked the lint development. Different levels of fertiliser combination had no effect on the fibre characters as reported by Iyengar (1941), Sen and Ahmed (1947) and Deo (1955).

Summary and conclusions

A study was undertaken at the Agricultural College and Research Institute, Vellayani, to determine the favourable time for cultivationof Sea Island Cotton and to assess the fertilizer requirements of this crop in that region. The results obtained are summarised below:

High soil moisture conditions resulted in a greater percentage of shedding of squares, flowers and bolls. Sowing in the first week of May increased the height of plants as compred to later sowings. A combination of 50 lbs N, 40 lbs P_2O_5 and 60 lbs K_2O per acre gave the maximum height for the plants. Early sowings produced greater number of flowers and bolls. A higher percentage of shedding was obtained as a result of late sowing. Longer fibres and increased fibre weight have been obtained for the earlier sowings. Different levels of fertiliser combinations had no significant response on the fibre characters. Sowing in the second week of May has given the highest yield of *kapas.* The fertilizer treatment of 40 lbs N, 30 lbs P_2O_5 and 50 lbs K_2O per acre has been found to give the maximum yields.

The results of the present study on Sea Island Cotton in the Vellayani region reveal that both high yield and good quality *kapas* can be obtained by sowing the crop in the first weak of May, provided there are adequate showers prior to the date of sowing for ensuring satisfactory germination. If there are no adequate showers a soaking irrigation can be given either just before sowing or immediately afterwards so as to enable the maximum number of seeds to germinate. A fertiliser combination of 40 lbs N, 30 lb P_2O_5 and 50 lbs K_2O per acre has been found to be a suitable dose to increase the per acre yield of Sea Island Cotton in the Vellayani area

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