QUEENSLAND DEPARTMENT OF PRIMARY INDUSTRIES

PLANTING TIME AND ASSOCIATED TEMPERATURE FACTORS AFFECTING COTTON PRODUCTION ON THE SOUTHERN DARLING DOWNS, QUEENSLAND

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SUMMARY

The effect of planting time on seedling emergence, growth characteristics and yield of seed cotton was investigated. Total emergence was significantly higher in the October 9 and 30 plantings than in the September plantings, differences being attributed to increase in soil temperature. Time to maximum emergence varied from 25 days in September-planted to 12 days in November-planted cotton.

Early-planted cotton showed slow initial growth, with cotton planted on September 18 taking 140 days from planting to reach peak flowering compared with 98 days for cotton planted on November 18.

While September plantings produced the highest total yields of seed cotton in this experiment, early October plantings are normally preferred in the short season environment on the southern Darling Downs characterized by a mean frost-free period of 191 days with a mean air temperature of 69°F for the six warmest months of the year.

I. INTRODUCTION

Marked seasonal variability in the length of the summer period (as determined by the occurrence of the last and first frosts of the respective winter periods) is a feature of the climatic conditions experienced at Hermitage Research Station (latitude 28·1°S.; elevation 1,575 ft) on the southern Darling Downs of Queensland. From 1954 to 1965 the frost-free summer period ranged from 128 to 238 days, with a mean of 191 days. The frost-free season exceeded the period of at least 6½ months (197 days) suggested by Basinski (1963) as being desirable for successful cotton production in only four of the 12 seasons.

Other factors which militated against successful cotton production on the southern Darling Downs were delayed planting rains and insufficient moisture during the fruiting phase from January to March.

Observations on the climatic barriers to cotton production on the southern Darling Downs were commenced at Hermitage Research Station in 1958.

To confirm earlier findings, a detailed time-of-planting trial was carried out at Hermitage in 1961-62 to study the effect of planting time on seedling emergence, growth characteristics and yield of seed cotton.

II. MATERIALS AND METHODS

A (6 x 2) x 5 split plot experiment was located on a self-mulching black clay soil. Two hundred seeds per plot were hand-planted to a uniform depth of 2 in. in 20 ft single-row plots spaced 42 in. apart. Plantings were made on September 18 and 26, October 9, 24 and 30, and November 11. The split plot arrangement allowed the inclusion of both dusted (Ceresan 1·5 w/w organically combined mercury) and untreated (no fungicidal dust) seed to demonstrate the significant protection afforded by mercurial fungicides, particularly at low soil temperatures, as confirmed by Bygott (1965). Empire was the variety used.

Seedling emergence was recorded at 2-day intervals after planting. After the counts were completed the trial was hand-thinned to a 6 in. plant spacing to provide a uniform stand for later yield determination.

III. RESULTS

(i) *Seedling emergence.*—Total seedling counts are given in Table 1. Weather conditions were unfavourable to germination following the October 21 and November 9 plantings. Total emergence was significantly higher in the October 9 and 30 plantings than in the September plantings. Time to maximum emergence varied from 25 days in September-planted to 12 days in November-planted cotton.

Seedling emergence was higher (1% level) with Ceresan-treated seed for all planting dates and the effect of Ceresan was more noticeable at the earlier plantings.

Rate of emergence was slower in the earlier plantings. Thus, there was no emergence of Ceresan-treated seed at 7 days in the September plantings, while counts of 48 and 76% were recorded at that stage for the October 9 and 30 plantings. The 28% increase in emergence between the October plantings was associated with a rise of 15°F (from 54 to 69°F) in the mean soil temperature at the 2 in. planting depth (recorded at 7.45 a.m. daily) over the 7-day germination periods. Daily mean hourly air temperatures (thermograph recording) also showed a rise (from 56 to 68°F) over the same periods.

(ii) *Growth pattern.*—Early-planted cotton showed slow initial growth. Cotton planted on September 18 took 140 days from planting to reach peak flowering, compared with 98 days for cotton planted on November 18.

Seedling mortality due to low air temperature was light. During the planting period the air temperature did not remain below frost level (30·4°F) for more than 1 hr on any nights when frosts were recorded.

TABLE 1

TOTAL SEEDLING EMERGENCE

Planting Date	Mean†			Equiv. %		
	Ceresan	Untreated	Means	Ceresan	Untreated	Means
A. Sept. 18	54·85	44·25	49·55	66·8	48·7	57·9
B. Sept. 26	49·80	35·90	42·85	58·3	34·4	46·2
C. Oct. 9	66·01	53·15	59·58	83 5	64·0	74·4
*D. Oct. 24	52·92	43·84	48·38	63·7	48·0	55·9
E. Oct. 30	68·08	60·25	64·17	86·1	75·4	81·0
*F. Nov. 8	54·53	51·90	53·22	66·3	61·9	64·2
Means	57·70	48·22	52·96	71·4	55·6	63·7

		Necessary Differences for Significance	
		5%	1%
Dates (Marginal)	1·396	4·12	5·62
Treatments (Marginal) ..	0·654	1·91	2·59
Dates x Treatments ..	1·602	4·68	6·34

Dates: E > C ⩾ A,B,D,F; A;F ⩾ B; F > D > B.

Treatments: Ceresan ⩾ Untreated.

The interaction Dates x Treatments is significant at the 5% level; the difference between Ceresan and Untreated is not as marked at the last planting date.

* Seed germination proved unsatisfactory in D & F treatments—extremely dry conditions followed planting on October 24, while 4 in. of rain was recorded after November 8.

† Inverse sine transformation.

Injury to seedling plant terminals by insects such as thrips, jassids and aphids was more prevalent (89% damaged terminals) in the slower growing September-planted than in November-planted cotton (21%).

Boll opening was slow because of the cool, humid autumn conditions. Between March and June, the monthly mean hourly air temperature dropped from 68 to 50°F, while the humidity remained fairly constant, averaging over 70%. With the marked tapering off of the summer season, cotton bolls in the top crop formation were generally undersized and contained a high proportion of immature cotton.

(iii) *Seed cotton yield.*—The effect of time of planting on yield and maturity of cotton is shown in Table 2. September-planted cotton produced the highest total yields, and plantings up to October 9 matured considerably earlier than later plantings.

IV. DISCUSSION

Except for the plantings of October 24 and November 8, differences between emergence counts may be attributed to increase in soil temperature. The

TABLE 2

YIELD AND MATURITY DATA

Planting Treatment	Hand-picked Seed Cotton Yield (lb/ac)					Percentage of Crop Harvested at Each Pick				
	First 24.iv.62	Second 9.v.62	Third 31.v.62	Fourth 26.vi.62	Total	First	Second	Intermediate Total	Third	Fourth
A. Sept. 18 ..	1,153	434	377	118	2,082	55·4	20·8	76·2	18·1	5·7
B. Sept. 26 ..	1,045	495	467	94	2,101	49·7	23·6	73·3	22·2	4·5
C. Oct. 9	910	412	365	98	1,785	51·0	23·1	74·1	20·4	5·5
D. Oct. 24	436	430	411	115	1,392	31·3	30·9	62·2	29·5	8·3
E. Oct. 30	477	425	417	131	1,450	32·9	29·3	62·2	28·8	9·0
F. Nov. 8	206	307	384	118	1,015	20·3	30·2	50·5	37·8	11·7
Mean	704	417	403	112	1,636	..	..	..	..	..

	First Hand Pick Significantly Exceeds		Total Harvest Significantly Exceeds	
	5%	1%	5%	1%
A.	C–F	C–F	C–F	C–F
B.	D–F	D–F	C–F	D–F
C.	D–F	D–F	D–F	D, F
D.	F	F	F	F
E.	F	F	F	F
F.				
Necessary Differences for Significance 5%	148		271	
Necessary Differences for Significance 1%	202		369	

minimum soil temperatures recorded at 2 in. planting depth at 7.45 a.m. daily over the period of the experiment were generally slightly above progressive weekly means recorded from 1958 to 1961, which ranged from 55·7°F for the week ending September 21 to 65°F for the week ending November 16. An exception was provided by a cold period early in October.

The accelerating effect of higher soil temperatures on the period from planting to maximum emergence has since been confirmed under field conditions at Hermitage by P. J. Goyne (1964, unpublished): time to maximum emergence varied from 25 days when planted on September 10 (mean minimum soil temperature 54·2°F at 2 in. depth over full germination period) to 5 days when planted on November 24 (mean minimum soil temperature 70·3°F).

Russian workers (Anon. 1957) suggested 50° as the minimum soil temperature for seeding cotton. Thurmond, Box, and Elliott (1959) stated that for best results the minimum soil temperature at a depth of 8 in. should not be lower than 60°F for 10 days before planting.

Experience at Hermitage has favoured deferring planting until a minimum soil temperature range of 58-60°F at the 2 in. planting depth has been reached to assure satisfactory germination and initial growth. Presumably the period for which cotton seed is subjected to temperatures below an acceptable minimum standard is more important than the actual minimum attained.

Harbison and Bygott (1962) showed that a close correlation ($r = 0{\cdot}998$) existed between 4 in. soil temperature at 9 a.m. and daily mean screen temperature at Hermitage over the September-November planting periods of 1954 to 1960. Thus it is not necessary to record actual soil temperatures in deciding when it is safe to plant cotton.

The period from early-November planting to peak flowering (98 days) corresponds with the normal time for cotton to reach peak flowering under irrigated conditions in Texas, U.S.A. (Thurmond, Box, and Elliott 1959).

A considerable time elapsed at Hermitage between emergence and squaring even in mid-October planted cotton—60-65 days instead of 35-40 days normally expected under the more favourable climatic conditions experienced in Central Queensland.

As the frosts occurring during the planting period of the trial were generally light (minimum air temperature not less than 29°F), reaction of seedlings to cold could not be gauged. Russian workers (Anon. 1957) have indicated that air temperatures of 29·3 to 28·4°F were lethal even after short exposure. The detrimental effect of low air temperatures on cotton is apparently associated with other factors such as soil moisture.

Basinski (1963) indicated that a mean minimum seasonal temperature of 71°F for the six warmest months of the year was necessary for uniform plant development. As shown in Table 3 the average air temperature during summer at Hermitage over the period 1953-1962 was 69°F and thus a longer growing season for cotton would be required to compensate for such a low mean temperature.

TABLE 3

AIR TEMPERATURE AND HUMIDITY AT HERMITAGE (10-YEAR AVERAGE, 1953–1962)

Temperature	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Mean (Six warmest Months)
Mean screen maximum (°F) ..	76·5	82·2	84·8	83·4	83·4	79·6	81·6
Mean screen minimum (°F) ..	49·1	54·6*	59·5*	60·5*	62·4	59·5	57·6
Mean hourly temperature (°F)	62·6	69·5	71·2	70·9	71·6	68·2	69·0
Mean hourly humidity (%) ..	62·6	62·5	64·3	67·7	71·2	74·0	67·0

* < 70°F for floral bud differentiation

The potential fruiting period for cotton on the southern Darling Downs is restricted, and apart from climatic considerations, if any other hazard such as insect attack, weed competition or hail damage interferes with the growth cycle, the ultimate effect on yield of seed cotton is serious, as the crop is generally incapable of recovering to the extent of producing economic yields within the short growing season.

While September-planted cotton produced the highest yields in this trial, the seasonal conditions were relatively mild, and early-October plantings are favoured to avoid the risk of prolonged exposure to low temperatures which reduce seed germination and retard early plant growth,

V. ACKNOWLEDGEMENT

The assistance of the Biometry Branch is acknowledged.

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(Received for publication February 12, 1968)

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