Studies on the growth of **G. barbadense** cottons in India. II. Responses to environmental stresses*1/

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COMPENDIO

Tres cultivares de Gossypium barbadense, *'Sujata', 'Suvin' y 'PSH' fueron sometidos a tensiones ambientales tales como horas reducidas de sol, altas temperaturas y fotoperíodo largo. Cuando las horas diarias de sol fueron reducidas a 3, se atrasó la floración de 10 a 15 días, se deprimió el crecimiento y decreció significativamente el rendimiento de algodón en rama. A excepción de 'Sujata', los otros dos crecieron satisfactoriamente en 6 horas diarias de sol, lo que indica que una situación que más o menos prevalece en la región central algodonera de la India, puede no ser un factor limitante para su crecimiento.*

Estos cultivares florecieron y maduraron temprano cuando se cultivaron en temperaturas más altas que lo normal en todo el ciclo, o durante los períodos de pre o posfloración. Las plantas fueron altas, hojosas, con mayor peso de tallos, y con peso de bellotas y rendimiento de algodón reducidos.

Los días largos solos atrasaron las floraciones significativamente, y aun en combinación con la temperatura produjeron un efecto similar. El incremento en crecimiento vegetativo fue debido principalmente a la temperatura alta. Los días largos y la temperatura alta, independientemente o en combinación, redujeron significativamente el peso de semilla y de fibra. Aunque 'PSH' y en cierto grado 'Suvin' mostraron resistencia a estas tensiones, su cultivo comercial en las zonas norteñas puede no ser practicable. Sin embargo, hay vastas áreas en las zonas central y sur donde pueden ser identificadas zonas muy apropiadas para su crecimiento balanceado y productividad ya que las condiciones climáticas en esas regiones no actuarán como factores limitantes a los que estos cultivares sean tolerantes, de tal manera que puede ser conseguida ulteriormente una autosuficiencia en algodones de fibras largas y extralargas. — Los autores.

Introduction

THE growth of cotton crops sown with rains in central and southern zones in India is adversely affected by cloudy weather and reduction in daily hours of sunshine until about the early flowering stage. It has been shown how changes in daily hours of sunshine during preflowering and postflowering phases of growth affect plant development and yield of two *Gossypium hirsutum* cultivars (2). Dastur (3) found that in northern zone higher air temperatures promoted luxuriant vegetative growth of *G. barbadense* cottons and along with long days suppressed the formation of fruiting branches

Between latitudes 30° N to 32° N comprising the states of Panjab, Haryana and Rajasthan, cotton crops are sown in April-May in summer when days are long and both day and night temperatures are high. Though the failures of *G. barbadense* cottons in north zone have been attributed to long days and high temperatures, no

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experimental evidence pinpointing one or the other factor has been put forth so far. The studies here reported on the effects of sunshine hours, and long photoperiods and high temperatures were therefore undertaken with a view to find out how far the new *barbadense* varieties can possibly adapt themselves to higher latitudes.

The studies on plant development and yield of these cultivars have been recently reported (1).

Materials and Methods

Three cotton cultivars, 'Sujata', 'Suvin' and 'PSH', were raised in large pots adequately manured. There were ten plants, one in each pot per treatment. The procedure followed for the experiments on the effect of sunshine hours was the same as described earlier (2).

The normal day length at Coimbatore (latitude 11° N) in summer is about 12 hours and 30 minutes. To simulate the conditions in northern tracts extra photoperiod for 2 hours was given by 60 candle power tungsten lamps. The day length around latitude 31° N is little over 14 hours, and maximum temperatures may fluctuate between 41°C and 44°C during early growth of cotton. To create high temperature along with long photoperiods, plants were grown in glass chambers fitted with tungsten lamps and maximum and minimum thermometers. The experiments were conducted in summer from March onwards. To judge the effect of photoperiod, cv. 'MCU-5' (*G. hirsutum* L.) which does not flower under long days was taken as check. It will be seen from Fig. 1 that day temperatures in glass chambers remained quite high up to the sixth week after germination and litle higher thereafter. Both light and light + temperature treatments were discontinued after 11 weeks when untreated plants produced a few flowers.

The maximum temperature in glass chambers then fell and the differences between what should have been in the north and in glass chambers, varied from 5°C to 7°C till the late bolling stages of groth. The minimum temperature on the other hand did not differ much till the 7th week, but fell in glass chambers subsequently and maintained a difference of about 4°C up to the 16th week. The glass chamber night temperatures were then steady around 21°C whereas those in northern aereas began to fall rapidly with the onset of winter.

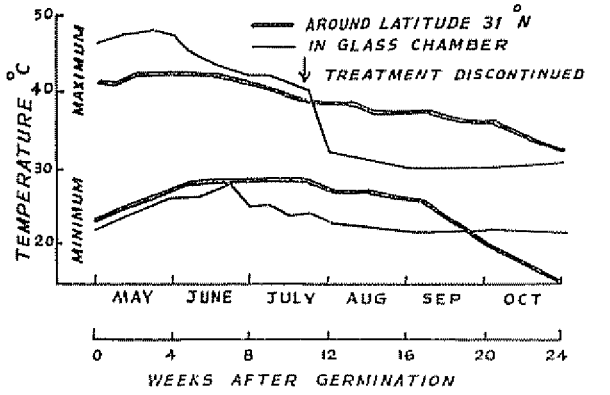

Fig. 1.—*Maximum and minimum temperatures around latitude 31° N and in glass chambers.*

The effect of higher than normal temperature was studied by keeping potted plants in a glass house where day temperatures were adjusted to fluctuate between 43°C to 45°C. The night temperatures during the treatment were between 25°C to 27°C. The temperature treatment was continued until about the 70th day after germination when the control plants began to flower. Thereafter the plants developed under normal conditions along with the untreated plants.

Results

Effect of sunshine hours

When daily hours of sunshine were reduced to 3, the number of days required for square formation increased by 13 and 14 days respectively in 'Sujata' and 'Suvin'; but 'PSH' was late by 6 days only (Table 1). Similary the square period of 'Sujata' and 'Suvin' increased by 26 and 31 days respectively with an increase of 13 days in the case of 'PSH'. When hours of sunshine were increased to 6 per day, 'Sujata' took about 6 more days to square and 'Suvin' took 2 more days than normal whereas 'PSH' was practically unaffected. Under 6 hours of sunshine the square period of the three cultivars remained more or less the same.

Reduction in sunshine hours affected the height of the plants (Table 2). 'Sujata' attained the maximum height under three hours treatment. Though the number of nodes increased equally in 'Sujata' and 'Savin' the former had longer internodes. 'PSH' was comparatively less affected. The first fruiting node was raised by 6, 5 and 4 respectively in the three cultivars. The

Table 1.—Effect of sunshine hours on phases of growth

Variety	Normal hours		Three hours		Six hours	
	Days to square	Days to flower	Days to square	Days to flower	Days to square	Days to flower
Sujata	32.6	59.0	45.2	85.6	38.3	57.8
Suvin	31.1	55.3	46.1	87.8	33.4	54.1
PSH	31.0	52.0	37.2	65.5	32.2	53.0

Table 2—Some growth characters per plant at maturity

Variety	Height cm	Number of nodes	First fruiting node	Number of sympodia	Weight of leaves g	Weight of stem g	Number of bolls	Seed cotton g
Normal hours of sunshine								
Sujata	67 0	23 5	8 5	12 0	13 4	60 0	6 5	20 2
Suvin	51 5	19 5	6 0	14 3	12 6	28 6	6 3	19 5
PSH	45 6	15 3	4 0	12 5	9 7	22 4	6 0	18 3
Three hours of sunshine								
Sujata	101 4	31 6	14 5	4 7	9 0	17 0	1 6	4 7
Suvin	64 2	31 6	11 5	6 5	6 5	17 5	1 5	5 0
PSH	59 1	25 0	8 5	6 5	8 5	13 9	1 0	2 9
Six hours of sunshine								
Sujata	57 5	14 5	9 0	6 0	8 8	29 4	3 1	10 3
Suvin	57 7	19 6	7 0	8 0	8 9	32 5	5 5	18 0
PSH	52 0	15 5	5 0	11 5	10 7	28 5	6 3	20 5
							S E	1 027
							C D at 1%	2 82

suppression of fruiting branches was greater in 'Sujata' whereas 'Suvin' and 'PSH' were more or less equally affected. The leaf weight decreased more in height and node number in 'Sujata' but increased inter nodal length in 'Suvin' and 'PSH' (Table 2). The first fruiting node was raised by one only. Both 'Sujata' and 'Suvin' suffered from reduction in number of sympodia but 'PSH' was nearly unaffected. The leaf and stem weight in 'Sujata' and leaf weight in 'Suvin' also decreased under this treatment. The stem weight of 'Suvin' and 'PSH' increased when compared with normal hours of sunshine. Except 'Sujata' where it was halved, the boll setting in the other two varieties was unaffected.

The daily six hours of Sunshine also decreased the 'Suvin' followed by 'Sujata', but 'PSH' showed only slight decrease. The stem weight of 'Sujata' was reduced rather drastically when compared of with 'Suvin' and 'PSH'. The three hour Sunshine treatment reduced boll production to 1 5 to 1 0 bolls per plant.

The yield of seed cotton was reduced significantly in all the varieties under three hours sunshine treatment, and also under six hours treatment in 'Sujata'. 'Suvin' and 'PSH' gave practically the same yield and appeared to be tolerant to reduction in sunshine hours to six so far as production is concerned.

Table 3—Effect of higher than normal temperature on some growth characters per plant var Suvin.

Treatment	Days to square	Square period	Boll period	Height cm	Bolls set	Weight of leaves and stem (g)	Boll weight (g)	Yield of seed cotton (g)
Normal temperature	40 5	26 5	48 2	116 2	9 1	102 9	3 1	24 5
Higher than normal temperature upto initial flowering	34 6	20 5	40 2	143 0	8 7	146 3	1 5	10.6

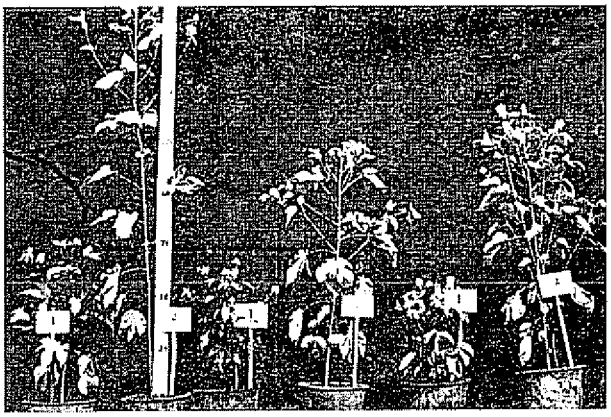

Fig. 2.—*The effect of high day temperatures on plant height at flowering. From left to right cv. Sujata, Suvin and PSH. 1 = untreated, 2 = high temperature treatment*

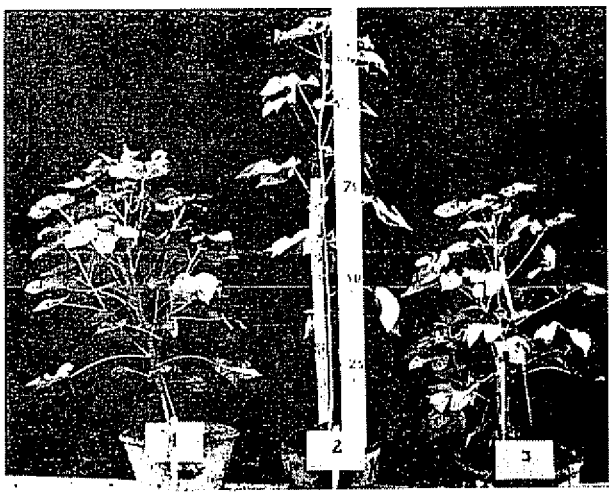

Fig. 3.—*The effect of long photoperiod on flowering cv. 1) MCU-5, 2) Sujata, 3) Suvin*

It was also found that reduction in sunshine hours either before the onset of flowering or after flowering significantly reduced production of dry matter and the yield of seed cotton in these varieties.

Effect of higher than normal temperature

The treated plants formed squares early and their square and boll periods were also reduced considerably (Table 3). At maturity the treated plants were taller and the leaf and stem weights were much higher than the normal plants. The effect of high temperatures on plant-height at flowering has been shown in Figure 2. There was marked increase in the height of the three varieties, the maximum being in 'Sujata'.

The treatment did not affect the number of bolls set. But the boll weight and the yield of seed cotton were appreciably reduced. Both "Sujata" and 'PSH' responded in a more or less similar manner as 'Suvin'. The high temperature treatments throughout the life cycle or during post flowering phase produced tall leafy plants with more of stem weight and their boll weights and yield were appreciably reduced.

Effect of photoperiod and temperature

The extended photoperiod delayed square initiation significantly in the three varieties (Table 4). The combined effect of long day and high temperature

Table 4.—Effect on square initiation

Treatment	Days to square			Square period (days)		
	Sujata	Suvin	PSH	Sujata	Suvin	PSH
Control	43.3	40.6	34.3	27.7	28.0	23.3
Long day	46.3	43.3	38.3	42.0	30.6	24.3
Long day + High temperature	57.0	42.0	40.6	29.3	28.3	26.3
S. E.	0.408	0.223	0.161	0.465	0.456	0.342
C. D. at 5%	1.601	0.878	0.631	1.825	1.790	1.342
	S.E.	*C.D. at 1%*		*S.E.*	*C.D. at 1%*	
V_1 vs V_2	0.658	2.432		0.921	3.414	
V_1 vs V_3	0.620	2.983		0.815	3.021	
V_2 vs V_3	0.390	1.441		0.806	2.987	

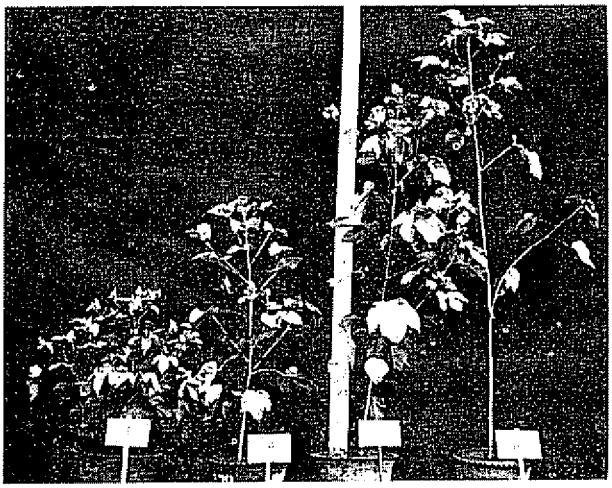

Fig. 4.—*The effects of light and temperature on cv. Suvin. 1) Control. 2) long days. 3) higher temperature. 4) long days and higher temperature*

was to further delay square initiation which was comparatively the longest in 'Sujata' followed by 'PSH' whereas 'Suvin' was delayed by two days only.

The long days enhanced square period of 'Sujata' by about a fortnight, but in 'Suvin' and 'PSH' it increased by a day or two only. A combination of day length and high temperature nearly nullified the effect of light alone in 'Sujata', had no effect on 'Suvin' but delayed square period of 'PSH' by 3 days.

Both the treatments delayed flowering significantly (Table 5). Under long days, 'Sujata' took 17 days more to flower than under normal day length, compared with about 5 days more in 'Suvin' and 'PSH'. The combined effect of light and temperature reduced the time to flower by 2 days in 'Sujata' and 3 days in 'Suvin' but increased the same by 4 days in 'PSH' when compared with long days alone. The three varieties thus responded differentially to the two treatments; 'PSH' being earlier than 'Sujata' and 'Suvin'.

The long days alone did not push up so much the first fruiting node of 'Sujata' but those of 'Suvin' and 'PSH' were raised by over 2 nodes. High temperature and long days together made 'Sujata' to flower at the 15th node when compared with the 10th node under long day treatment alone whereas 'Suvin' and 'PSH' were affected insignificantly.

It will be seen from Figure 3 how long photoperiods affected flowering. In plant No. 1 which is 'MCU-5' (*G. hirsutum* L.) and taken as check, not even a square was produced under continuous long photoperiods. Under similar conditions, 'Sujata' (plant Nº 2) had few squares about to be opened into flowers, but 'Suvin' had flowered earlier (plant No. 3). Also note increase in height of 'Sujata' under long days.

The plants of 'Suvin' under the three treatments at the advanced stage of flowering have been shown in Figure 4. The height increased under long day conditions. The high temperature treatment alone was mainly responsible for abnormal increase in height though light in combination with high temperature increased it still further. 'Sujata' and 'PSH' were more or less similarly affected by these treatments.

The other growth characters were recorded at maturity and are given in Table 6 and 7.

Under long days the production of fruiting branches was not affected significantly though 'Suvin' recorded

Table 5.—Effect on flowering and first fruiting node.

Treatment	Days to flower			First fruiting node		
	Sujata	Suvin	PSH	Sujata	Suvin	PSH
Control	71.0	68.6	57.6	9.0	5.8	4.3
Long day	88.3	74.0	62.6	10.3	8.5	6.6
Long day + high temperature	86.3	70.3	67.0	15.3	8.8	7.6
S. E.	0.508	0.524	0.842	0.216	0.526	0.377
C. D. at 5%	1.994	2.056	3.505	0.848	2.064	1.479
	S. E.	*C. D. at 1%*		*S. E.*	*C. D. at 1%*	
V_1 vs. V_2	1.032	2.526		0.807	2.991	
V_1 vs. V_3	1.394	3.411		0.615	2.279	
V_2 vs. V_3	1.381	3.379		0.916	3.395	

Table 6.—Effect on the production of sympodia and bolls per plant.

Treatment	Sympodial branches			Bolls		
	Sujata	Suvin	PSH	Sujata	Suvin	PSH
Control	9.3	12.6	13.1	3.0	3.4	3.8
Long day	10.3	15.3	12.1	5.1	4.1	4.8
Long day + high temperature	15.3	16.6	10.0	2.6	3.1	4.1
S. E.	0.394	0.806	0.258	0.076	0.108	0.064
C. D. at 5%	1.546	3.163	1.101	0.299	0.424	0.254
	S. E.	*C. D. at 1%*		*S. E.*	*C. D. at 1%*	
V_1 vs. V_2	1.269	4.704		0.187	0.693	
V_1 vs. V_3	0.666	2.468		0.141	0.522	
V_2 vs. V_3	1.196	4.434		0.178	0.659	

numerical increase. In combination with light high temperature however, effected significant increase in 'Sujata' and 'Suvin', and a decrease in 'PSH' (Table 6).

The long days alone enhanced boll production but when combined with high temperature reduced boll number in Sujata without adversely affecting 'Suvin' and 'PSH'.

The weight of leaves was slightly affected by long days in 'Sujata', decreased significantly in 'Suvin' and was unaffected in 'PSH' (Table 7). The long days and temperature increased the leaf weight to one and a half times in 'Sujata', doubled it to what it was when light alone was given in 'Suvin' whereas 'PSH' was not influenced.

The weight of stem was more or less similarly affected as the leaf weight except that long day treatment reduced it to less than half when compared with the control.

Effect on leaf area and leaf-expansion

The total leaf area per plant at different stages of growth as affected by thermophotoperiodic treatments

Table 7.—Effect on weight of leaves and stem.

Treatment	Weight of leaves (g)			Weight of stem (g)		
	Sujata	Suvin	PSH	Sujata	Suvin	PSH
Control	7.9	7.2	6.6	20.6	23.2	13.6
Long day	8.8	5.0	6.3	25.7	13.5	5.7
Long day + high temperature	12.8	10.1	6.7	38.0	28.3	14.7
S. E.	0.086	0.208	0.195	0.479	0.527	0.949
C. D. at 5%	0.339	0.816	0.765	1.880	2.068	3.689
	S. E.	*C. D. at 5%*		*S. E.*	*C. D. at 5%*	
V_1 vs. V_2	0.319	1.182		1.007	3.733	
V_1 vs. V_3	0.302	1.119		1.503	5.571	
V_2 vs. V_3	0.403	1.493		1.535	5.690	

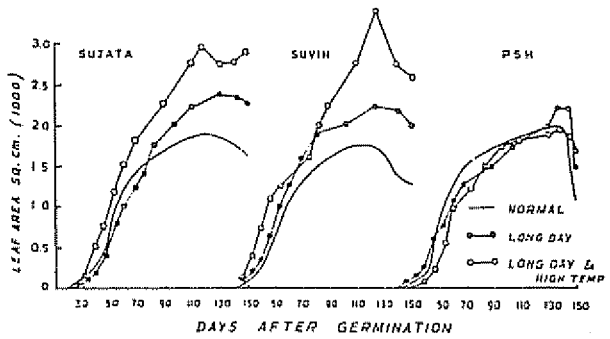

Fig 5.—*The effects of thermophotoperiodic treatments on leaf area.*

have been shown in Figure 5. The light and temperature combination increased the leaf area from the beginning in 'Sujata' and 'Suvin'. The effect of long days was more perceptible after flowering. At the later stages the early treatment of long days along with high temperature increased the leaf area more rapidly than long days alone in 'Sujata' as well as in 'Suvin'. It was remarkable that these treatments were practically ineffective in 'PSH'.

As the cotton plant produces main stem leaves as well as sympodial leaves, it would be interesting to know how expansion of these leaves was affected by thermophotoperiodic treatments. As a typical case the relative rates of expansion can be judged from Figure 6, where these changes in the case of 'Sujata' have been shown. The main stem leaf expanded rapidly for the first 20 days and the rate comparatively was little slowed down but remained constant for the following 40 days, decreased a little for another 20 days, and subsequently showed no change under normal conditions. For the first fortnight long day treatment singly as well as in combination with high temperature expanded main stem leaf with equal rapidity to over one and a half times than the untreated leaf.

Subsequently expansion under long day treatment was at more or less the same rate as the control until the 80th day of their emergence whence further expansion occurred in the former. The leaf-expansion was still rapid when day length combined with high temperature and continued to be higher till 105th day.

When compared with the control and long day treatments, the high temperature cum-long day treatment delayed expansion of the sympodial leaf till about 40th day. The treatments had no effect upto the 80th day when further expansion of the untreated leaf nearly stopped. After the 80th day the long day treatment was also ineffective but its combination with high

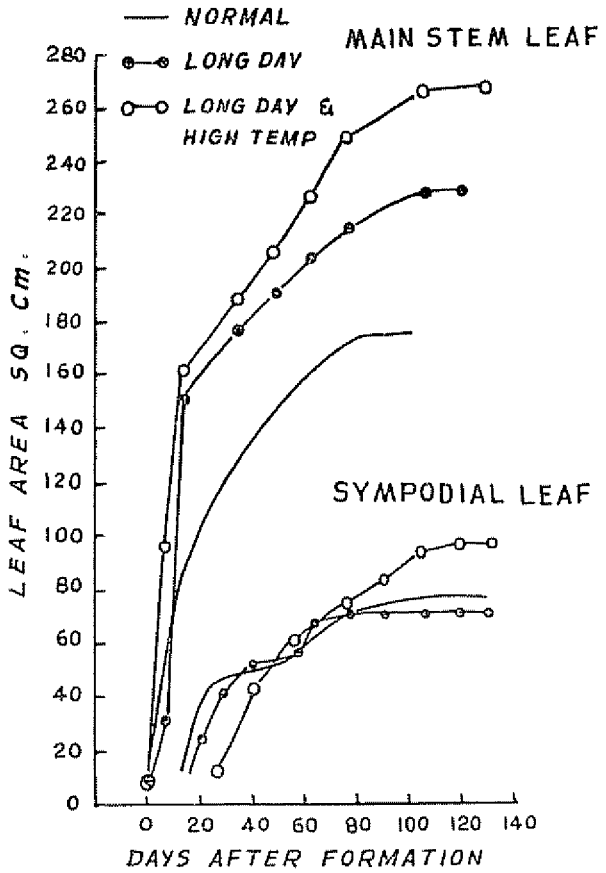

Fig 6.—*The effects of termophotoperiodic treatments on leaf expansion of Sujata.*

temperature continued to expand the leaves upto 120th day after their formation.

The two treatments reduced the boll weight significantly (Table 8). The reduction in boll weight was more when long day and high temperature were combined.

There was significant increase in yield of seed cotton in the three varieties under long day conditions. Both long day and high temperatures together reduced the yield of 'Sujata' to nearly half and that of 'Suvin' to about 3/4 the yield of untreated plants. It was noteworthy that this treatment had no effect on the yielding capacity of the cultivar 'PSH'.

The weight of seeds as well as lint decreased under the two treatments (Table 9). 'Sujata' suffered more from losses in seed and lint weight.

The lint weight of 'Suvin' was just significantly reduced under the combined treatment of long days and higher temperatures but this stress did not appear to affect the lint yield of 'PSH' though its seed weight was nearly halved.

Table 8.—Effect on boll weight and yield of seed cotton.

Treatment	Boll weight (g)			Seed cotton (g)		
	Sujata	Suvin	PSH	Sujata	Suvin	PSH
Control	3.3	3.4	3.3	8.0	10.0	8.1
Long day	2.1	3.0	2.5	11.1	12.3	11.6
Long day + high temperature	1.7	2.5	2.4	4.2	7.0	8.2
S. E.	0.028	0.057	0.026	0.180	0.339	0.106
C. D. at 5%	0.113	0.226	0.103	0.707	1.132	0.416
	S. E.	C. D. at 1%		S. E.	C. D. at 1%	
V_1 vs. V_2	0.091	0.338		0.543	2.013	
V_1 vs. V_3	0.055	0.205		0.295	1.094	
V_2 vs. V_3	0.089	0.333		0.502	1.860	

The late formed bolls also recorded lower boll weights. Thus even though the treatments were discontinued after flowering, the stress experienced earlier was reflected in boll growth.

Discussion

The importance of bright weather and adequate hours of sunshine has long been recognised as a major factor influencing the growth of cotton. In Karnataka, Dastur and Narsimhachar (5) found summer crops of *G. barbadense* cotton to grow and yield better than the winter crops. Except the north zone, most of the cotton sowings in India are done from June to July after the onset of south-west monsoon. The day temperatures do not rise above 33°C during the vegetative phase and the day length is not long enough to prevent flowering of even the short day plant like 'MCU-5'. Under these conditions the cotton plant produces subnormal vegetative structure and picks up growth only by mid-September with the return of bright weather (4). Thus for the cotton plant to give economic returns, it should produce enough growth under the

Table 9.—Effect on the weight of seeds and lint.

Treatment	Weight of seeds (g)			Weight of lint (g)		
	Sujata	Suvin	PSH	Sujata	Suvin	PSH
Control	2.3	2.1	2.1	1.0	1.3	1.2
Long day	1.3	1.6	1.5	0.9	1.4	1.0
Long day + high temperature	0.9	1.4	1.1	0.8	1.1	1.2
S. E.	0.050	0.029	0.091	0.019	0.040	0.064
C. D. at 5%	0.196	0.113	0.357	0.075	0.160	0.254
	S. E.	C. D. at 1%		S. E.	C. D. at 1%	
V_1 vs. V_2	0.081	0.303		0.063	0.237	
V_1 vs. V_3	0.147	0.545		0.295	0.354	
V_2 vs. V_3	0.135	0.500		0.131	0.486	

conditions of low light and reduced hours of sunshine. Among the three cultivars, 'Suvin' and 'PSH' produced sufficient dry matter and gave practically the same number of bolls and seed cotton yield under six hours of sunshine as under normal conditions. During the monsoon months there are periods of bright sushine throughout the day and at times for 2 to 6 days in succession there will be no sunlight. The experiments indicated that varieties like 'Suvin' and 'PSH' are likely to put up good growth under similar conditions.

Under higher than normal temperatures the plants flowered early as the periods for square initiation and square to flower formation were reduced. This is in agreement with the early findings on *G barbadense* cottons by several workers (3, 6, 8, 9). This treatment also reduced boll period and boll weight, and increased the height and total dry matter.

Though there were varietal differences in flowering when long days or long days and high temperature were imposed as treatments, long days alone delayed flowering significantly. The cultivar 'PSH' however behaved little differently. Lewis and Richmond (7) have shown that flowering in *G. barbadense* is under gene control. The combination of long photoperiod and high temperature reduced the time taken for flowering in 'Sujata' by 2 days and in 'Suvin' by 3 days, but further delayed it in 'PSH' by 4 days, when compared with long days alone. This supports the observations made by Waddle, as quoted by Lewis and Richmond (7) that in a physiological system the genes operating under a certain day length are operative only when other envirormental factors such as temperature are interacting in such a manner as to permit their expression. Among the three cultivars comparatively early flowering of 'PSH' may be attributed to its day-neutral parent 'Pima'.

The increase in vegetative growth which made the plants extra tall, leafy and spreading was brought about more by temperature. Because similar effects were produced when temperature treatment alone was given or when it combined with long days. The long days alone or in combination with high temperature significantly reduced the seed and lint weight in 'Sujata' and 'Suvin' whereas these treatments had no effect on the lint weight of 'PSH'. In the northern zone boll weights of even *G. hirsutum* cottons range from 3.0 g. to 3.3 g. In the present experiments the late formed bolls also recorded lower boll weights. Thus long photoperiods as well as high temperatures independently contributed to reduction in boll weight and the stress so experienced by the plant continues to operate till late flowering and bolling, even long after considerable reduction in day length and temperature.

'Sujata', which is a selection from Egyptian 'Karnak', could not adjust so much to several environmental stresses to which it was subjected. Only the indigenously bred varieties 'Suvin' and 'PSH' appeared to withstand more the effects of low light and reduced hours of sunshine, long photoperiods and high temperatures. By proper adjustments in their dates of sowing and plant population there should be no difficulty in growing 'Suvin' and 'PSH' in different agroclimatic areas in central and southern zones. Successful performances of 'Suvin' in the farms of progressive growers in the states of Andhra, Karnataka, Maharashtra and even between the latitudes 24°N and 25°N in southern Rajasthan in the north lends support to this approach.

The yield of seed cotton per hectare in these tracts varied from 25 to 39 quintals.* The high temperature stress given to these varieties was in fact more than normally experienced in the northern zone. The major deffects that the northern environment produces on growth are an abnormally bushy vegetative structure and reduction in boll weight. The former reduces the plant efficiency and the latter adversely affects the yield of seed cotton. Therefore, even though the cultivars like 'Suvin' and 'PSH' may prove successful in small scale trials, their commercial cultivation in the north cannot be feasible. In fact it is not necessary that such quality cottons should be grown under extreme environmental stresses when vast areas elsewhere in India are available for their successful cultivation.

The annual requirements of 0.4 to 0.5 million bales of quality cottons met with through imports can be easily substituted under extra-long staple category (0.1 million bales and over) by growing 'Suvin'. The remainning quantities of long staple cotton will not be difficult to produce through types like 'PSH'.

Summary

The three varieties Sujata, Suvin and PSH were subjected to environmental stresses such as reduced hours of sunshine, high temperature and long photoperiod.

When daily hours of sunshine were reduced to 3, flowering was delayed by 10 to 15 days, growth was depressed and the yield of seed cotton decreased significantly. Except 'Sujata', the other two varieties grew satisfactorily under 6 hours of daily sunshine indicating that more or less a similar situation prevailing in the central cotton growing zone may not be a limiting factor for their growth.

These cultivars flowered and matured early when grown under higher than normal temperatures throughout, or during pre or post flowering stages. The plants were tall, leafy with more of stem weight, and their boll weights and yield were much reduced.

The long days alone delayed flowering significantly, and even in combination with temperature produced similar effect. The increase in vegetative growth was mainly due to high temperature. The long days and

* 1 quintal = 112 pounds = 50.8 kg.

high temperature independently or in combination significantly reduced the seed and lint weight. Though 'PSH' and to certain extent 'Suvin' appeared to withstand these stresses, their commercial cultivation in the northern tracts may not be practicable. However, there are vast areas in central and southern zones where pockets most suitable for their balanced growth and productivity can be identified as weather conditions in these regions will not act so much as limiting factors to which these types are tolerant so that self sufficiency in long and extra-long stapled cottons can ultimately be achieved

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NOTAS Y COMENTARIOS

Publicaciones

Revista Centroamericana de Nutrición y Ciencias de Alimentos. Con este nombre se inició una publicación trimestral del Instituto de Nutrición de Centro América y Panamá (INCAP). El segundo número, que es el que tenemos a la vista, correspondiente a abril-junio 1976, tiene un artículo de investigación, "Nutrición, ciclo vital y desarrollo humano", de 15 páginas pero con numeración en números romanos (como si fuera una introducción). Después continúa la publicación de los programas del INCAP que abarcan en este número las políticas nacionales de alimentación y el programa de dietas.

Producción Animal Tropical. Editado por el Consejo Estatal del Azúcar, de la República Dominicana, ha aparecido en 1976 la revista *Producción Animal Tropical*, dedicada principalmente a los problemas de la producción de los rumiantes en el trópico húmedo. El primer número tiene una revisión de literatura de T. R. Preston (redactor en jefe) sobre caña de azúcar y producción bovina y los resúmenes de los trabajos presentados en la Primera Reunión Anual del Centro Dominicano de Investigación Pecuaria con Caña de Azúcar. Al parecer, la revista, desde el segundo número, ha pasado a ser un condominio de CEAGANA (Rep. Dominicana) y CIEG (México). La periodicidad es cuatrimestral y la dirección en México es: Centro de Investigación y Experimentación Ganadera, Calle Alvaro Obregón 27, Chetumal, Q. R., México.

Venezuela Forestal. La Compañía Nacional de Reforestación (CONARE), organismo oficial autónomo de Venezuela, ha comenzado a publicar una revista trimestral, *Venezuela Forestal*. El primer número, que tiene fecha setiembre de 1976 tiene artículos sobre el *Pinus caribaea*, y sobre el cáncer del eucalipto (de L. Golfari). La dirección es: Avenida Andrés Bello, Edificio Andrés Bello, 7º piso; Torre Oeste Nº 73-0, Caracas.

Selecciones de Reseñas de Libros. La Biblioteca y Servicios de Información del Centro Internacional de Agricultura Tropical (CIAT) ha iniciado un servicio para sus usuarios, *Selecciones de Reseñas de Libros*, con el fin de mantenerlos al día en lo que se refiere a los libros que van apareciendo en el mundo. Consiste en reproducciones completas de recensiones seleccionadas de las revistas que llegan al CIAT. Se publica cada dos meses en fascículos dedicados a ciencias agrícolas, ciencias pecuarias y ciencias sociales, esta última auspiciada por el CEDEAL (Centro de Documentación Económica de América Latina). El número que hemos recibido, de Ciencias Sociales, abarca además de economía de la agricultura, asistencia económica, inflación, precios agrícolas, desarrollo, temas auxiliares como métodos estadísticos, diseños experimentales, econometría, programación, modelos económicos e investigación operatoria.