CHAPTER VII

A PHYSIOLOGICAL COMPARISON OF THE GROWTH OF THE COTTON PLANT AT LYALLPUR (PUNJAB) AND AT INDORE (MALWA)

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(a) Comparison of soil and climatic conditions.

The writer had an opportunity to study the growth of the cotton under different conditions of sowing date, spacing and manuring in the Punjab during the years 1939 to 1941 and to collect the detailed growth data. It was, therefore, of interest to study these data in relation to the similar data collected at Indore to determine the effects of differences in the soil and climatic conditions prevailing in these two tracts on the growth of the cotton plant. It may be mentioned that there is a big difference in the soil conditions of the two tracts. The Punjab soils are light sandy or sandy loams containing 10 to 20% of clay, while the Malwa soils are black heavy soils containing about 50% of clay. The growth of the cotton was, therefore, bound to be affected by such differences in the soil conditions existing in the two regions. The same remarks apply to the weather conditions which are also entirely different as will be shown below.

Another important difference in the soils of the two tracts is the presence of free sodium salts in patches in the Punjab subsoils. Pastur and his colleagues (1946) have clearly shown how the presence of these salts in the subsoil produces brack conditions. No such salinity in the cotton subsoil
exists in Indore and consequently no symptoms similar to tirk are found in the cotton crop in Malwa. The physiological comparison of the cotton plant in the two tracts is, therefore, made for soils free of salinity.

The cotton crop in the Punjab was generally sown in the month of May. June sowings have been found by Kasur and his coworkers (1944) to suffer less from tirk than the May sowings. Similarly June sowings with closer spacings than normal in vogue at that time gave equally high yields in non-tirk patches and higher yields in tirk patches than May sowings. As the cotton crop in Malwa was also sown in June after the first break of the monsoon, only the June sowings in both the tracts are taken for this study.

Fig. XVI shows the differences in the weather conditions prevailing in the two tracts during the growth of the cotton crop from June to January. The weather conditions studied are maximum and minimum temperatures, rainfall, relative humidity, wind velocity and number of rainy days.

The following are the main points of difference between the climatic conditions of the two tracts:

The maximum temperatures are higher in the Punjab than at Indore during the period of vegetative growth and in the beginning of the fruiting period, i.e., up to October after which temperatures in the Punjab fall rapidly.

The minimum temperatures are higher during the vegetative
Fig. XVI: Graphs of meteorological data for Indore (Malwa) and Lyallpur (Punjab).

- **Maximum Temperature**
- **Relative Humidity**
- **Minimum Temperature**
- **Wind Velocity (M.P.H.)**
- **Rainfall (Inches)**
- **No. of Rainy Days**

Graphs show data for Indore (x) and Lyallpur (○) over the months of May to January.
period of growth and lower during the reproductive period in
the Punjab than at Indore.
The rainfall is higher at Indore than in the Punjab especially
up to October.
The relative humidity is higher at Indore than in the Punjab
during the vegetative growth period of the crop.
Though the mean velocity of wind at Indore is higher than in
the Punjab during the vegetative growth period, it may be
mentioned that Punjab growing season was characterised with
periodical sand storms when the velocity of wind varied from
30 to 60 miles per hour for a few hours at a time.
The number of rainy days are more at Indore than at Lyallpur
during the vegetative growth and fruiting periods of the
crop.

(b) Growth comparison.

The differences in the climatic conditions described
above produced marked differences in the growth of crop in
the two tracts. They are shown in Figs. XVI to XX and
Table XXVIII and are discussed below.

Table XXVIII....
Table XXXIII
A comparison of growth and fruiting of American cotton grown at Lyallpur (irrigated) and at Indore (rainfed).

<table>
<thead>
<tr>
<th>Characters</th>
<th>Lyallpur</th>
<th>Indore</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Height in cms.</td>
<td>88.2</td>
<td>41.1</td>
</tr>
<tr>
<td>2. Internode number</td>
<td>35.9</td>
<td>22.5</td>
</tr>
<tr>
<td>3. Internodal length in cms.</td>
<td>2.46</td>
<td>1.81</td>
</tr>
<tr>
<td>4. Dry weight per plant in gms.</td>
<td>178.0</td>
<td>13.6</td>
</tr>
<tr>
<td>5. Dry weight per unit length</td>
<td>2.02</td>
<td>0.33</td>
</tr>
<tr>
<td>6. Position of first fruiting node</td>
<td>19.6</td>
<td>11.3</td>
</tr>
<tr>
<td>7. Initiation of buds (days after sowing)</td>
<td>76.0</td>
<td>49.3</td>
</tr>
<tr>
<td>8. Initiation of flowers (days after sowing)</td>
<td>94.0</td>
<td>78.2</td>
</tr>
<tr>
<td>9. Initiation of bolls</td>
<td>132.0</td>
<td>135.7</td>
</tr>
<tr>
<td>10. Maturation of bud to flower</td>
<td>18.0</td>
<td>27.9</td>
</tr>
<tr>
<td>11. Maturation of flower to boll</td>
<td>46.0</td>
<td>57.5</td>
</tr>
<tr>
<td>12. Vegetative branches on the main stem</td>
<td>18.2</td>
<td>0.31</td>
</tr>
<tr>
<td>13. Fruiting branches on the main stem</td>
<td>9.2</td>
<td>12.1</td>
</tr>
<tr>
<td>14. Total fruiting nodes on the plant</td>
<td>151.0</td>
<td>25.4</td>
</tr>
<tr>
<td>(Potential fruiting capacity)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15. Flowers per plant</td>
<td>78.5</td>
<td>8.1</td>
</tr>
<tr>
<td>16. Bolls per plant</td>
<td>27.6</td>
<td>1.72</td>
</tr>
<tr>
<td>17. Boll weight</td>
<td>2.01</td>
<td>1.99</td>
</tr>
<tr>
<td>18. Yield per plant</td>
<td>55.5</td>
<td>3.42</td>
</tr>
<tr>
<td>19. Fruiting coefficient</td>
<td>0.23</td>
<td>0.25</td>
</tr>
<tr>
<td>20. Nitrogen percentage at maturity</td>
<td>(O) 1.48 (O) 2.055</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(N) 2.18  (N) 2.119</td>
<td></td>
</tr>
<tr>
<td>21. Yield per acre</td>
<td>9.5</td>
<td>3.5</td>
</tr>
</tbody>
</table>
Fig. XVII: Comparison of plant development: (a) height; (b) percentage increase in height; (c) number of internodes and (d) internodal length at Indore (Malwa) and Lyallpur (Punjab).
In the Punjab a more rapid growth in extension occurred than under Indore conditions giving rise to greater height per plant in the former tract. Greater height was made up of longer internodes and greater node production (Fig. XVII-a & b). The same was true of the dry weight attained per plant.

The dry weight per plant at Indore was, therefore, comparatively small as compared with the dry matter produced per plant in the Punjab (Fig. XVIII-a). These wide differences in the extension growth and in the production of dry matter per plant were caused by the wide differences in the soil and climatic conditions prevailing in the two tracts. In the Punjab the soils are light sandy promoting quicker growth. The temperatures are high and days are longer giving rise to higher assimilating activities at least for the first three months after sowing. All these conditions are conducive to vigorous vegetative growth. In Indore the conditions, as already stated, are not so favourable for vegetative growth and consequently the vegetative plant structure produced was small.

Though the differences in the actual height attained were wide in the two tracts, there was some similarity in the trends in extension growth. In both cases extension growth was more rapid during the first 105 days after sowing after which the extension growth declined (Fig. XVII-a). Even the greatest percentage increase in growth occurred at 70 day stage in the Punjab and about 82 day stage at Indore (Fig. XVII-b). There was no further increase in the inter-
Fig-XVIII: Comparison of plant development: (a) dry weight; (b) percentage increase in dry weight; (c) relative growth rate and (d) net assimilation rate at Indore (Malwa) and Lyallpur (Punjab).
nodal length after 75 days in the Punjab and after 90 days at Indore. At Indore no such big rise in the extension growth was visible. It remained fairly constant, the internodal length varying from 1.25 to 1.5 cm. at different stages of growth. This difference between Punjab and Indore may be due to well drained condition of the soils and the waterlogged conditions that exist at Indore during the months of July, August and September. No increase in extension growth is possible after September on account of the initiation of the flowering phase which commences from the first week of September.

On the other hand the dry matter production in the Punjab was extremely high from the very early stages while that was not the case at Indore where the increase in dry matter began to occur more rapidly after 105 day stage (Fig. XVIII-a & b). This difference was due to the differences in the climatic conditions. This was also borne out by the curves given for the relative growth rate and net assimilation rate in Fig. XVIII(a & d). The relative growth rate and net assimilation rate were much higher in the Punjab than at Indore in the first 70 days after sowing. The relative growth rate and the net assimilation rate were higher at Indore than in the Punjab after that stage except for a secondary maximum in the later tract during the period of active boll formation at 100 day stage. Such secondary rise in the relative growth rate and net assimilation rate were also visible at Indore at 120 day stage after sowing.
Fig. XIX: Comparison of flowering and bolling at Indore (Malwa) and Lyallpur (Punjab). X---X Indore, O---O Lyallpur.

FLOWERS PER PLANT PER DAY,
(a)

(b) PERCENTAGE OF FLOWERS TO TOTAL.

(c) FLOWERS PER SQ. YARD PER DAY.

(d) BOLLS PER PLANT PER DAY.

(e) PERCENTAGE OF BOLLS TO TOTAL.

(f) BOLLS PER SQ. YARD PER DAY.

DATES OF FLOWERING.

DATES OF BOLLING.
which was the time for active flowering and fruiting.

The flowering curves (flowers per plant per day) for the two tracts are given in Fig. XIX. Flowering began in the first week of September in both the tracts but the number of flowers produced per plant was much smaller at Indore than in the Punjab. This was natural on account of the wide difference in the vegetative growth produced in the two tracts. The number of fruiting nodes was only 25 at Indore while it was 151 in the Punjab. The number of flowers produced per plant in the Punjab was nearly ten times the number produced at Indore. Similarly the number of bolls produced per plant was much higher in the Punjab than in Indore (Table XXXVIII).

One important difference in the flowering curves for the two tracts was the sudden rise in the rate of flowering in the Punjab just after the initiation of flowering. There was a peak in the flowering curve. The maximum was attained on 29th September. Thus flowering occurred in a flush after which there was a sudden and rapid fall. Such trends were not exhibited at Indore where the rate of flowering rose to a small extent followed by a gradual decline. This difference in the flowering rate in the two tracts was a result of the difference in the rate of vegetative growth. The vegetative growth in the early stages in the Punjab was extremely vigorous and consequently the fruiting points were greater in number on the plant. Active vegetative growth must have produced a concentration of elaborated food materials
quite enough for giving rise to bud and flowers at many points on the plant at the same time. Thus flowering occurred in a flush. That was not the case at Indore where production of dry matter was slow during the early stages of growth; consequently the vegetative growth was small, bearing a few fruiting points. The vegetative growth was quickened at the time of flowering on account of more favourable weather conditions and consequently fresh points for flowering developed as flowering proceeded. This brought about a gradual and small rise in the rate of flowering and a gradual decline. The percentage of total flowers produced, therefore, was higher in the early stages of flowering in the Punjab, and they were higher in the later stages of flowering at Indore. (Fig. XIX).

Though the total number of flowers and bolls and the total yield per plant were much higher in the Punjab than at Indore it was remarkable that the fruiting coefficients (i.e. seed cotton produced for the total dry matter per plant) were nearly the same at both the places. It was nearly 23% in Punjab and 27% in Indore.

The initiation of buds occurred earlier at Indore than in the Punjab as the temperatures were too high in the latter tract for the production of fruiting branches which were suppressed under high temperatures and consequently the position of the first fruiting node was higher on the main stem in the Punjab than in Indore (Table XXXVIII).
The square period was longer at Indore than in Punjab; so there was not much difference in the appearance of first flower after sowing between the two places. Perhaps lower maximum temperature and high humidity at Indore was responsible for this difference in the maturation period of the squares. The first open boll at Indore appeared almost after a later than at Lyallpur fortnight. The maturation period for the flower into boll (boll period) also was longer at Indore than in the Punjab (Table XXXVIII).

This difference in the maturation period of bolls in the two tracts did not appear to be caused so much by the differences in temperature as the temperatures are not lower at Indore than in the Punjab during the boll maturation period. It may be pointed out that the maturation period in the Sudan and Egypt were higher than in the Punjab inspite of the fact that temperatures were higher in these countries than in the Punjab during the fruiting season.

The longer boll maturation period at Indore, Sudan and Egypt than in the Punjab may, therefore, be due to the soil differences. In the first three tracts the soils are heavy clay while the soils in the Punjab are sandy loams. The entire growth of the plant at Lyallpur is more rapid on account of the sandy nature of the soil than at Indore, and the growth of the bolls proceeds less rapidly. It is also possible that on account of a lower assimilation rate at Indore, the availability of elaborated food materials is not
Fig. XX: Comparison of boll development at Indore (Malwa) and Lyallpur (Punjab). ——— Indore, O—O Lyallpur.

(a) VOLUME
(b) LENGTH
(c) DIAMETER
(d) DRY WEIGHT
(e) CARPEL
(f) BOLL WEIGHT

Dry weight per boll in gms.
Dry weight of carpel per boll.
Boll weight in gms.

Volume per boll in c.c.
Length per boll in mm.
Diameter per boll in mm.

Age in days.
rapid and the growth proceeds at a slower rate. Dastur (1950) has recently shown that more rapid growth of bolls in Sind than in the Punjab was due to rapid availability of food nutrients on account of a higher assimilation rate. Therefore the bolls in Sind could mature in 35 to 40 days during the early stages of boll setting.

A comparison of the growth of bolls in the Punjab and at Indore (Fig. XX) showed many interesting features. Though the length of the boll and its diameter were nearly equal in the two cases, the volume of the boll and total dry weight of the boll were higher in the Punjab than at Indore. This difference in the dry weight may be due to the differences in the availability of food nutrients. The higher boll weight in the Punjab was mostly due to higher carpel weight than a higher seed cotton weight as shown in the graphs. The growth of the carpels at Indore appears to be suppressed 21 days after the boll is set while the growth of the carpel in the Punjab continues up to 35 days.