CHAPTER I

INTRODUCTION

(a) General

Malwa is one of the important rainfed cotton growing tracts in the Indian Republic. It lies between 21°-22' and 26°-52' N and 74°-0' and 83°-0' E. The Malwa plateau, a wide table land with a mean elevation of 1,600 feet above the sea level, consists of 34,637 square miles. It includes the country lying between the Vindhyaa barrier which forms the northern bank of Narmada valley and a point just south of Gwalior; its eastern link is marked by a ridge which runs from south to north starting near Bhilsa and its western link marches into the southern districts of Rajasthan. It now includes the districts of Dhar, Ratlam, Jabua, Mandsaur, in Shajapur, Rajgarh, Indore, Dewas and Ujjain/Madhya Bharat, northern portion of Bhopal State and southern parts of Chittore, Kotah and Jhalawar districts of Rajasthan.

The total area under cotton crop in Malwa is nearly ten lac acres while the production is about two and a half lac bales. Though this has been regarded a short staple area, a high quality cotton locally known as Marwari (G.hirsutum) is also grown either as a pure crop or mixed with desi cotton known as Malvi (G.arboreum race bengalense). The yield per acre of the American Upland cotton (variety Indore I) is, however, low compared to the yields obtained
under irrigated conditions in the alluvial soils of the Punjab and Sind. It is about 60 lbs. of lint equivalent to about 180 lbs. of seed cotton per acre. Even though the yield is low, the quality of lint of American varieties is fairly good, the staple length of Indore I being 7/8th of an inch capable of spinning 22 to 25 H.S.W.C.

The American Upland cotton is grown in this tract under rainfed conditions. No information, however, is available on the physiology of growth of these cottons under rainfed conditions. With a view to determining the causes of low yields and the optimum conditions for its growth, it was decided to undertake the study of the physiology of American cotton under rainfed conditions. It was also considered necessary to determine mineral uptake by the crop under waterlogged conditions which generally prevail in this tract during the rainy months of July, August and a part of September.

The climatic conditions prevailing in this tract do not appear to be favourable for the vegetative growth of the American Uplands. This can be seen from the meteorological data given in Table I. The cotton crop is generally sown

Table I

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<tbody>
<tr>
<td>Mean max. temp. °F</td>
<td>103.8</td>
<td>95.3</td>
<td>82.7</td>
<td>82.1</td>
<td>83.7</td>
<td>88.3</td>
<td>83.1</td>
<td>79.1</td>
<td>78.4</td>
</tr>
<tr>
<td>Mean min. temp. °F</td>
<td>76.5</td>
<td>75.3</td>
<td>71.3</td>
<td>70.9</td>
<td>69.5</td>
<td>61.8</td>
<td>52.6</td>
<td>48.2</td>
<td>49.1</td>
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<tr>
<td>Rel. humidity</td>
<td>46.3</td>
<td>73.1</td>
<td>89.8</td>
<td>90.4</td>
<td>88.4</td>
<td>62.3</td>
<td>49.9</td>
<td>53.7</td>
<td>49.1</td>
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<tr>
<td>Mean hrs. of sunshine</td>
<td>10.01</td>
<td>7.77</td>
<td>2.58</td>
<td>2.64</td>
<td>5.87</td>
<td>8.87</td>
<td>9.17</td>
<td>8.87</td>
<td>8.45</td>
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<tr>
<td>Rainfall (inches)</td>
<td>0.50</td>
<td>5.64</td>
<td>13.43</td>
<td>10.19</td>
<td>8.47</td>
<td>1.85</td>
<td>0.89</td>
<td>0.14</td>
<td>0.18</td>
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on rains after the break of the south west monsoon in the second or the third week of June or later in some years. Once the rainy season sets in, the temperatures go down and the days remain cloudy. The mean hours of sunshine are about 2.5 in July and August. The soil remains saturated with moisture on account of heavy rains in the months of July and August so much so that some of the fields become waterlogged. Thus the cotton plant receives a great set back in its vegetative growth. It may be expected that pre-monsoon sowings with well irrigation would produce better growth as then the root system would be better developed during pre-rain period. It was, therefore, considered of importance to study the effect of sowing date along with spacing and manuring on the growth of the cotton crop.

The black cotton soils can be divided into two main types:  

(1) Shallow soils which are waterlogged during the monsoon;  

(2) Deep soils which are well drained.

In the first type, murram (lime concretions) mixed with stones was found at a depth varying from 1\(\frac{1}{2}\) to 2 feet from the soil surface while no such murram layer was found to be present up to a depth of 6 feet or more in deep well drained soils. Thus during the rainy months there was water within 1\(\frac{1}{2}\) feet of the soil surface on such waterlogged lands and the conditions for growth were, therefore, different in the two soil types. It was necessary to study the effect of different
factors singly and in combination on the growth of the crop separately in the two soil types.

The American cotton crop in this tract is generally attacked by Jassids which give a great set back to the growth of the crop. The leaves when attacked with Jassids curl up and turned red in patches. In addition to this type of reddening there is a physiological reddening which has its appearance in the rain sown crop at the time of fruiting in the months of October or November. It was considered necessary to include in this study the effect of various factors on the time of the incidence of this type of reddening. It was also necessary to determine the causes that produce leaf reddening in the American Upland cottons grown under rainfed conditions in the Malwa tract.

It was also necessary to study if the poor vegetative growth and the reddening of leaves were due to any deficiency of the rare elements in the soil. It was, therefore, undertaken to investigate that point.

(b) Review of literature.

The effect of sowing time on yield has been studied in almost all the cotton growing tracts. Crowther (1935-38) studied its effect on the growth and yield of cotton in Egypt and the Sudan by arranging multifactor experiments so that various interrelationships between different factors
could be studied simultaneously. Earlier sowings (25th February) in Egypt gave higher yield than late sowings while in the Sudan crop August sowings gave highest yields. Dastur and Mukhtar Singh (1942) also found that in Punjab June sowings in combination with close spacing give better yields than May sowings as the former do not suffer as much from 'tirak' or bad opening of bolls as the May sowings.

The importance of spacing on yield of cotton has been realised ever since Duggar (1899) conducted spacing experiments on cotton. Since then many investigators have studied the effect of spacing on cotton yields. Their results quoted by Colling (1920) indicated that close spacing gives best results. The main findings of Gregory, Crowther and Lambert (1932), Crowther and Mahmoud (1935) and Crowther, Tomforde and Mahmoud (1937) were that close spacing increased the yields and this increase was more in the late sown crop than in the early sown crop. 25 cms. between holes and 65 cms. between ridges were also found to be the optimum spacings. Dastur and Mukhtar Singh (1942) also found that close spacing was necessary for the late sown crop while the early sown crop did not generally profit by adopting close spacing. Thus there was an interaction between sowing date and spacing.

Manuring was another factor that has been found to influence the growth of the cotton crop. Fertilizers have been used since 1860 for manuring cotton on soils that are depleted of its nutrients (Brown, 1938). Considerable
literature since the discovery of Liebig on the value of fertilizers has accumulated and that has been summarised by Brown (1938) in his book on cotton. But the effects of the important elements nitrogen, potassium and phosphorus on the morphological development of the cotton plant were first determined by Crowther (1938) in the Sudan and by Dastur (1946) in the Punjab.

Crowther (1934) found nitrogen to increase the meristematic activity of the plant resulting in an increase in the node and flower production. It also increased the relative growth rate but it was found to produce no effect on net assimilation rate. Water on the other hand increased the growth in extension by elongation of internodes. At the bolling stage absorption of nitrogen was found to decline on account of suppression in the root growth brought about by a lack of carbohydrate supply. Soil nitrogen was, therefore, of no importance at that stage and it should, therefore, be applied at an early stage. Crowther (1934) also found that application of a high dose of nitrogen should be accompanied by a heavy watering. He also found a significant correlation between nitrogen content of the leaves of seedlings within two weeks after sowing and the final yield.

The same author (1938) conducted a number of experiments in Egypt to determine the effects of phosphatic manures on the development and yield of cotton plant but the results obtained did not show any constant response to the fertilizers
on yield. Crowther (1936) also found that superiority in
yield of a variety was not a result of greater height and node
production. Tall varieties gave less yield than less tall
varieties. A study of the distribution of nitrogen in the
plant body revealed that varietal responses in yield response
to nitrogen were not related to the percentage nitrogen content
of the leaves. A lower nitrogen content of the leaves did
not mean a higher response to nitrogen on yield and vice versa.

Dastur and Mukhtar Singh (1944) in their investigations
on 'tirak' in the Punjab American cottons found that 'tirak'
symptoms developed in the crop on light sandy soil deficient
in nitrogen and that they could be remedied by the application
of nitrogen. Nitrogen was found to be the most potent factor
on light sandy lands as it increased both the vegetative and
reproductive growth. It increased the meristematic activity,
flowers, bolls, boll weight and yield when applied to such
lands. It was also found to prolong the functional activities
of the leaves thus delaying senescence. This was contrary to
the findings of Crowther (1934). Nitrogen also increased net
assimilation rate in addition to efficiency index (relative
growth rate) but it did not alter the other inherent characters
of growth as the general trends with peaks and depressions were
not shifted by its application. Late application contrary to
findings of crowther (1934) in Egypt was found to be slightly
better than an early application. Though application of
nitrogen proved so beneficial on light sandy lands it had no
effect on lands that were saline in the subsoil.
The beneficial effects of nitrogen on light sandy lands were found to diminish as the sowings were done later. Thus nitrogen starvation in the plant was avoided by cutting down the vegetative growth by late planting so much so that there was little response to nitrogen on the growth of the late sown crop. Another symptom of nitrogen deficiency was yellow red leaf disease in Sind American cottons. Dastur and Kanwar Singh (1947) in their investigations on the red leaf distinguished two types of red leaf viz., green red and yellow red. The latter type was caused by a deficiency of nitrogen. The leaves got rapidly depleted of nitrogen on account of quick maturation of the crop and consequently they turned yellow and red.

The investigations by Crowther and his colleagues (1934-38) in Egypt and the Sudan and by Dastur and his colleagues (1939-47) in the Punjab and Sind were conducted under the irrigated conditions. No such detailed investigations on the growth of American Uplands under rainfed conditions have been reported anywhere. This study was, therefore, undertaken on American Uplands grown in the black cotton soils of Malwa.

In view of what is discussed above it was decided to study the growth of the crop under different conditions of sowing date, spacing and manuring.

It may be mentioned here that some preliminary experiments on the effect of sowing time and detailed experiments on the effect of manuring on yield had been conducted in this tract. Coventry (1918) in one of his reports mentioned an experiment on cotton at Ratlam in which cotton was sown with
irrigation in the month of May before the break of monsoon in which a yield of 1,200 lbs. of seed cotton per acre was recorded. Kuber Singh and Wad (1934) conducted replicated trials with pre-rain sowings and rain sowings as separate treatments and they found a significant increase in yield by early sowings. These experiments were conducted without reference to soil types, spacing or manuring. Panse (1945) summarised the manurial experiments conducted at Indore and his main conclusion was that response to nitrogen was high on rich lands and low on poor lands. There was also an increase in response with the increasing dose of nitrogen. All these experiments were, however, conducted with desi cottons sown with rains.

The cotton crop in this tract was sown in rows 14 inches to 24 inches apart. No special study has been made regarding optimum spacing for the cotton sown on different dates.

Thus in previous work the experiments on cotton were conducted for a study of single factors and, therefore, no information is available on the interrelation of these factors. In these experiments the effect on yield was only determined and growth studies were not attempted. Mostly desi cottons were experimented upon. Thus the need for such an investigation was indeed great.