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# Climatology of the Crop Seasons of India — I. Rice*

A. K. MALLIK

*Meteorological Office, Poona*

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ABSTRACT. On the basis of the data collected under the All India Co-ordinated Crop Weather Scheme, the normal growth features and the yield of the rice crop in India are discussed in relation to the climatology of the rice crop season. The study covers 7 stations with data for more than 10 years. Information is presented about the chronology and growth attributes of the crop, the average durations of the crop growth periods and the average climatic features of the crop season and their variabilities separately for each of the growth periods. It is shown that there is a remarkable consistency in the duration of the reproductive period of the crop as compared to the vegetative period. The average date of flowering of the autumn crop at different stations is found to be greatly dependent upon the geographical co-ordinates of the stations and conform to 'Hopkins' Bioclimatic Law', though with a little modification of Hopkins' criteria.

## 1. Introduction

Under the All India Co-ordinated Crop Weather Scheme, quantitative observations are being recorded at a network of selected experimental farms, on the growth, yield and the incidence of diseases and pests of rice, wheat, jowar, sugarcane and cotton crops, side by side with the weather experienced by the crops, during their life-cycle. Details of the crop and meteorological observations recorded as well as the sampling technique used for recording the observations are given in Agrimet Technical Circular No. 50. The crop weather data recorded each year, at each station, are reviewed in the Annual Reports on Agricultural Meteorology of the India Meteorological Department. The data are also summarised in pictorial crop weather diagrams which are being published in annual volumes beginning with the data for 1957-58. In this paper, normal growth features and the yield of the rice crop are discussed in terms of the climatology of the rice crop season, as assessed from the data collected so far. It may be noted that all values in this paper represent the averages based on more than 10 years of data.

## 2. The crop life-cycle

Although in some parts of India a succession of the rice crop is grown practically throughout the year, the important ones are the autumn and the winter crops. The autumn crop is fed by the rainfall received during the southwest monsoon season, supplemented by irrigation, if possible and necessary, because of protracted breaks in the monsoon rains. The winter crop is grown generally with irrigation and in the eastern half of the peninsular India with whatever rain is received during the northeast (retreating southwest) monsoon season. The seed is sown in nurseries and the seedlings are later transplanted in prepared fields. During the period from sowing to transplantation, germination of the seed takes place and the seedlings grow to a stage suitable for transplantation. During the next period, from transplantation to flowering, each plant starts producing a number of culms (tillering), soon after transplantation, and the culm to plant ratio progressively increases to a maximum value; thereafter, the plants start growing rapidly in height till flowering, by which time the maximum

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height is attained. However, under field conditions, usually the two phases tillering and elongation cannot be clearly distinguished, the end of the tillering phase overlapping with the beginning of the elongation phase. During the last period from flowering to harvest, setting and development of the grains and general drying up of the plants take place and the crop becomes ready for harvest.

### 3. Average crop and average season

Crop weather observations on rice are being recorded on the autumn crop at 16 and on the winter crop at 5 agricultural experimental stations in India. Data for periods of 2 to 16 years, varying from station to station have become available. In this paper, the average crop and the average season at such of the stations where data for more than 10 years have been collected are presented and discussed. The stations, season of the rice crop under crop weather observations, geographical co-ordinates and the number of years for which data are available are given in Table 1. As a background to what follows, a brief account of the rainfall (by far the most important single meteorological factor for the rice crop of India) at the stations mentioned in Table 1, is given below.

Karjat and Pattambi, situated close to the west coast of India, are on the windward side of high mountains (Western Ghats). Thus, being in the direct sweep of the southwest monsoon and backed by high mountains, Karjat and Pattambi receive, during the southwest monsoon season, very heavy orographical rainfall. On the other hand, Samalkota and Aduthurai situated very near the east coast are on the leeward side of highlands (Eastern Ghats and Deccan Plateau). Therefore, falling in a 'rain shadow' zone, Samalkota and Aduthurai receive only small rainfall. Chinsurah and Labhandi, lying in open plain and without any special orographical feature, receive moderate rainfall. Consequently, of the stations given in Table 1, the autumn crop at Chinsurah, Labhandi, Karjat and Pattambi is mainly dependent on the rainfall of the southwest monsoon, while the autumn crop at Samalkota and Aduthurai and the winter crop at all the three stations, *viz.*, Aduthurai, Coimbatore and Pattambi, are grown with irrigation and with whatever rain is received during the southwest monsoon (June to September) and the northeast (October to December) monsoon seasons.

The average crop and the average season, at the stations mentioned in Table 1, are presented in the following sections.

#### (*A*) *Average crop*

The chronology of crop phase and values of important growth attributes of the crop at the different stations are given in Table 2. The values in Table 2 give an idea of the average rice crop at the respective stations.

##### (*i*) *Sowing and transplantation*

It will be seen from Table 2 that there is considerable variation in the crop phases and growth attribute from station to station, in the autumn as well as the winter crop. At Chinsurah, Labhandi, Karjat and Pattambi, the crop is raised almost entirely with the water received from southwest monsoon (June to September) rainfall. Therefore, at these stations, the crop periods are closely connected with the progress of the southwest monsoon. In the case of the autumn crop at Samalkota and Aduthurai, as also for the winter crop at all the three stations, rainfall is supplemented by irrigation from tanks and wells and therefore, at these stations, the crop periods are somewhat less closely connected with rainfall. The normal rainfall received during the months of May, June and July at the different stations (with autumn crop) are given below.

**Normal rainfall (mm)—Autumn crop only**

| Station | May | June | July |
|---|---|---|---|
| Chinsurah | 147 | 248 | 291 |
| Labhandi | 23 | 230 | 381 |
| Karjat | 16 | 551 | 1266 |
| Samalkota | 62 | 135 | 195 |
| Aduthurai | 61 | 54 | 52 |
| Pattambi | 159 | 582 | 694 |

**TABLE 1**

**Station and data**

| Station | Cropping season | Co-ordinates | | | Number of years for which data have been collected |
|---|---|---|---|---|---|
| | | Lat. (N) | Long. (E) | Alt. (m) | |
| (1) | (2) | (3) | (4) | (5) | (6) |
| Chinsurah | Autumn | 22° 52′ | 88° 24′ | 8 | 16 |
| Labhandi | ,, | 21° 16′ | 81° 36′ | 285 | 11 |
| Karjat | ,, | 18° 55′ | 73° 18′ | 51 | 16 |
| Samalkota | ,, | 17° 03′ | 82° 13′ | 845 | 12 |
| Aduthurai | Autumn and winter | 11° 01′ | 79° 30′ | 19 | 13 |
| Coimbatore | Winter | 11° 00′ | 77° 00′ | 424 | 13 |
| Pattambi | Autumn and winter | 10° 48′ | 76° 12′ | 25 | 13 |

**TABLE 2**

**Chronology and growth attributes of the crop**

| Station | Average dates of | | | | Average values of growth attributes | | | |
|---|---|---|---|---|---|---|---|---|
| | Sowing | Transplantation | Flowering | Harvest | Number of seedlings transplanted per bunch | Highest culm/plant ratio | Height attained (cm) | Out-turn of grain (metric ton per hectare) |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| *Autumn crop* | | | | | | | | |
| Chinsurah | Jun 20 | Aug 8 | Oct 23 | Dec 7 | 3 | 3·7 | 87 | 2·51 |
| Labhandi | Jul 1 | Aug 29 | Oct 17 | Dec 2 | 1 | 4·4 | 67 | 1·75 |
| Karjat | Jun 11 | Jul 8 | Oct 4 | Nov 4 | 10 | 1·5 | 90 | 2·04 |
| Samalkota | Jun 3 | Jul 7 | Oct 14 | Nov 25 | 2 | 3·4 | 131 | 3·37 |
| Aduthurai | Jun 29 | Jul 26 | Sep 6 | Oct 16 | 2 | 3·8 | 94 | 3·12 |
| Pattambi | May 29 | Jul 10 | Sep 18 | Oct 23 | 2 | 4·3 | 93 | 2·18 |
| *Winter crop* | | | | | | | | |
| Aduthurai | Jul 31 | Sep 13 | Dec 19 | Feb 1 | 2 | 4·1 | 118 | 4·06 |
| Coimbatore | Jul 20 | Sep 2 | Dec 2 | Jan 25 | 2 | 3·6 | 97 | 3·89 |
| Pattambi | Sep 30 | Nov 9 | Dec 28 | Feb 11 | 2 | 5·9 | 57 | 1·69 |

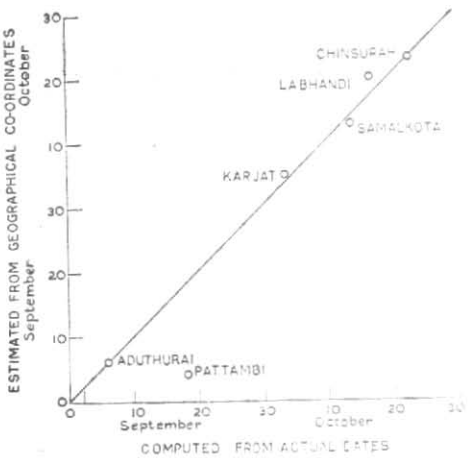


**Fig. 1. Average dates of flowering of rice crop (Autumn crop only)**

It will be seen from the rainfall values (p. 556) that the 'adequacy of water' condition (about 200-300 mm of rainfall) is reached earliest at Pattambi, next at Karjat, then at Chinsurah and latest at Labhandi, which is also the sequence of the dates of sowing, as well as the dates of transplantation at these stations (except that transplantation at Karjat is a little earlier, because of the extremely heavy rains of July). At other stations, as mentioned earlier, the crop is raised with irrigation and, therefore, the dates of sowing and transplantation are not entirely controlled by rainfall.

*(ii) Vegetative growth*

It is interesting to note from Table 2 that at Karjat where the number of seedlings transplanted per bunch is very high, the highest culm/plant ratio is also very low than at the other stations. This is a balancing effect in nature, stabilising the number of culms in a unit area of the field.

Comparing the values of height attained and out-turn of grain, there appears to be a direct relationship (though not strictly quantitative) between these two growth attributes. Therefore, the height attained by the crop is one of the important factors to be taken into account in any attempt to forecast the yield of the rice crop in India.

*(iii) Flowering*

Irrespective of the dates of transplantation, the sequence of the dates of flowering for the autumn crop (col. 4 of Table 2) shows that flowering is generally delayed with increase in latitude. According to Hopkins' (1918) 'Bioclimatic Law', other conditions being equal, the time variation of a periodical natural phenomenon in North America is at the average rate of 4 days to each degree of latitude, 5 degrees of longitude and 400 feet of altitude. The sequence of the dates of flowering of the autumn rice crop at the different stations does not strictly conform with these criteria of Hopkins. Nevertheless, a good fit of the average flowering dates at the different stations is obtained if Hopkins' criteria are a little changed and the flowering is considered to be delayed by 3·8 days for each degree of latitude, 0·2 days for each degree of longitude and 16·0 days for each kilometre of altitude. Fig. 1 shows the average date of flowering as given in Table 2 (computed from the actual yearly dates) plotted against the corresponding dates as estimated from the geographical co-ordinates on the basis mentioned above, for the different stations. Fig. 1 shows that except at Pattambi, the agreement between the two sets of dates is quite close. It will be seen from Table 1 and Fig. 1 that although the latitudinal difference between Pattambi and Aduthurai is less than quarter of a degree, the flowering of the crop at Pattambi is about 10 days later than at Aduthurai. As seen from Table 5, during the vegetative period of the autumn crop, Pattambi has more rain, much less sunshine and lower temperatures than at Aduthurai. It would thus appear that, considering the latitude of Pattambi, the period of the vegetative growth of the autumn rice crop here is characterised by less sunshine and lower

temperatures, which perhaps account for the flowering being delayed. Taking into account the wide geographical distribution of the stations and the consequent large differences in the varieties and cultural practices used in raising the crop at the different stations, the agreement is indeed striking. This is another remarkable example of the predominant effect of weather on crops and appears to hold out the possibilities of the prediction of the date of flowering of the rice crop in an area making use of the geographical co-ordinates.

(*iv*) *Yield*

The values of out-turn show that, broadly speaking, the yield per unit area is greater in the southern parts than in the central and northern parts of India.

The yield for the winter crop at Pattambi is the lowest. From Tables 5 and 6, it will be seen that, as compared to the other stations, the winter crop season at Pattambi is characterised by lowest rainfall and too much of sunshine during the vegetative period and no rain and highest day temperatures during the reproductive period. Rice being a hydrophilous crop, the cumulative effect of the above factors is responsible for the very low yield of the winter crop at Pattambi.

(*B*) *Average season*

The whole crop season can be conveniently divided into 3 periods, *viz.*, seedling period (from sowing to transplantation), vegetative period (from transplantation to flowering) and reproductive period (from flowering to harvest). The average duration of the above three periods at the different stations are given in Table 3, together with their coefficient of variability (immediately below each average value, within brackets).

The values given in Table 3 show that (*i*) of all the three crop periods, the vegetative period is generally the longest and its duration least variable; Labhandi being the only exception where the seedling period is longer

**TABLE 3**

**Crop growth periods**

| Station | Average length (weeks) | | |
|---|---|---|---|
| | Seedling period | Vegetative period | Reproductive period |
| (1) | (2) | (3) | (4) |
| *Autumn crop* | | | |
| Chinsurah | 7 (16) | 11 (10) | 7 (11) |
| Labhandi | 8 (18) | 7 (19) | 7 (16) |
| Karjat | 4 (13) | 13 (7) | 4 (15) |
| Samalkota | 5 (18) | 14 (11) | 6 (23) |
| Aduthurai | 4 (16) | 6 (14) | 6 (12) |
| Pattambi | 6 (10) | 10 (5) | 5 (11) |
| *Winter crop* | | | |
| Aduthurai | 6 (15) | 14 (7) | 6 (15) |
| Coimbatore | 6 (16) | 14 (13) | 7 (12) |
| Pattambi | 6 (20) | 7 (12) | 7 (14) |

Note — Figures within brackets represent the coefficients of variability

and with the same variability as the vegetative period, (*ii*) the duration as well as the variability of the seedling and reproductive periods at a particular station are of the same order, (*iii*) considering both the autumn and the winter crop at all the stations together, there is a marked consistency in the average lengths (weeks) of the reproductive period, compared to those of the vegetative period of the crops, (*iv*) the total span of crop life is markedly short for the autumn crop at Aduthurai and (*v*) the variability from season to season in the span of crop life is markedly less in the case of the autumn crop at Pattambi. Perhaps this is due to the fact that amongst the stations considered, the onset of the southwest monsoon is earliest and the

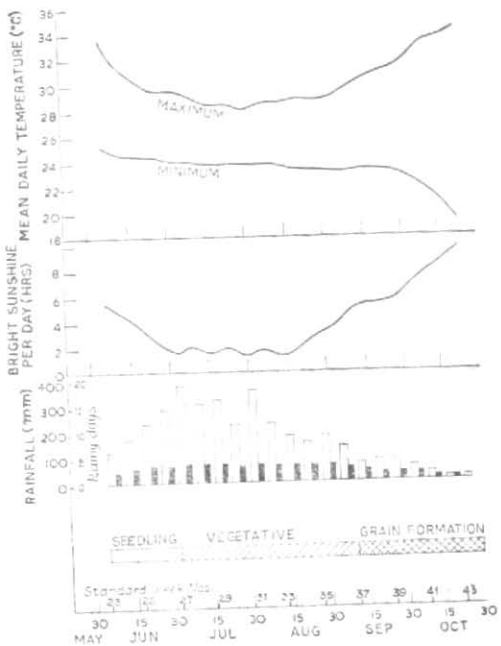


**Fig. 2. Crop climatogram — Rice**
**Karjat (18°55′N, 73°18′E, 51 metres)**

withdrawal latest at Pattambi. So that, at this station, the duration of monsoon conditions being longest, a little delay in the onset or a little earlier withdrawal of the monsoon do not affect the crop so much as at the other stations.

#### 4. Climatology of the crop periods

The meteorological factors covered in this review are rainfall, rainy days (days with rainfall of 2·5 mm or more), sunshine and maximum and minimum temperatures. The average weekly values, based on a number of years (col 6, Table 1), together with their coefficients of variability for each week from sowing to harvest were computed. However, as presentation and discussion of the weekly values will be too lengthy, average of the weekly values of the elements as well as the coefficients of variability, separately for each of the three different crop periods, are presented in Tables 4, 5 and 6 for the seedling, vegetative and reproductive periods respectively. The normal weekly values (average of weekly values of each of the years) of the meteorological factors for the whole of the crop season in respect of Karjat are depicted pictorially in Fig. 2, as a crop climatogram. The crop climatogram shows at a glance the march of climatological factors week by week during the crop season at Karjat.

The values given in Tables 4, 5 and 6 give an idea of the variation in the meteorological conditions under which the rice crop is raised in India.

The coefficients of variability in Tables 4, 5 and 6 show that the year to year variability of the weekly values is highest for rainfall and lowest for the temperatures. This is why in India, rainfall is by far the most important single meteorological factor for the rice crop. Judging from the total rainfall received by the crop during the whole life cycle (sowing the harvest) and considering both the autumn and winter crops together,

**TABLE 4**

**Climatology — Seedling period**

| Climatic element (mean per week) | Autumn crop | | | | | | Winter crop | | |
|---|---|---|---|---|---|---|---|---|---|
| | Chinsurah | Labhandi | Karjat | Samalkota | Aduthurai | Pattambi | Aduthurai | Coimbatore | Pattambi |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) |
| Rainfall (mm) | 58 | 72 | 202 | 21 | 12 | 158 | 23 | 11 | 47 |
| | (68) | (82) | (81) | (105) | (165) | (62) | (134) | (121) | (107) |
| Rainy days | 4 | 4 | 5 | 2 | 1 | 5 | 1 | 1 | 2 |
| | (45) | (47) | (35) | (71) | (145) | (36) | (119) | (97) | (83) |
| Bright sunshine (hrs) | 35 | 24 | 28 | 36 | 43 | 22 | 49 | 37 | 46 |
| | (38) | (47) | (55) | (51) | (29) | (67) | (24) | (35) | (26) |
| Mean daily max. temp. (°C) | 31·7 | 30·7 | 31·3 | 34·6 | 35·0 | 29·4 | 33·1 | 30·5 | 31·3 |
| | (2) | (4) | (3) | (5) | (3) | (3) | (3) | (3) | (3) |
| Mean daily min. temp. (°C) | 25·9 | 24·3 | 24·7 | 26·2 | 25·7 | 23·2 | 24·8 | 22·3 | 23·0 |
| | (2) | (2) | (1) | (3) | (2) | (1) | (2) | (2) | (2) |

Note—Figures within brackets represent coefficients of variability

**TABLE 5**

**Climatology — Vegetative period**

| Climatic element (mean per week) | Autumn crop | | | | | | Winter crop | | |
|---|---|---|---|---|---|---|---|---|---|
| | Chinsurah | Labhandi | Karjat | Samalkota | Aduthurai | Pattambi | Aduthurai | Coimbatore | Pattambi |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) |
| Rainfall (mm) | 51 | 51 | 210 | 42 | 24 | 80 | 41 | 21 | 17 |
| | (87) | (78) | (80) | (98) | (125) | (82) | (126) | (156) | (218) |
| Rainy days | 3 | 2 | 6 | 2 | 1 | 4 | 2 | 1 | 1 |
| | (67) | (76) | (32) | (70) | (81) | (61) | (77) | (83) | (43) |
| Bright sunshine (hrs) | 42 | 36 | 20 | 37 | 47 | 30 | 48 | 48 | 62 |
| | (25) | (23) | (48) | (27) | (29) | (42) | (23) | (25) | (19) |
| Mean daily max. temp. (°C) | 31·7 | 30·8 | 29·2 | 31·8 | 33·2 | 29·2 | 30·7 | 30·6 | 32·9 |
| | (2) | (3) | (3) | (4) | (3) | (3) | (3) | (3) | (3) |
| Mean daily min. temp. (°C) | 25·3 | 23·8 | 23·6 | 25·2 | 24·9 | 22·9 | 23·2 | 21·1 | 21·7 |
| | (2) | (2) | (1) | (2) | (2) | (1) | (2) | (3) | (4) |

Note—Figures within brackets represent coefficients of variability

the stations fall into three distinct groups as shown below—

Group I— Rainfall of more than 2000 mm — autumn crops at Karjat and Pattambi

Group II— Rainfall of about 750-1000 mm — autumn crops at Chinsurah, Labhandi, Samalkota and winter crop at Aduthurai

Group III— Rainfall of less than 500 mm— autumn crop at Aduthurai and winter crops at Coimbatore and Pattambi

It may be seen from Table 2 that the variation in the average yield from station to station is highest within Group III, consisting of Aduthurai (autumn), Coimbatore and Pattambi (winter). The autumn crop at Aduthurai as well as the crop at Coimbatore are grown as "swamp" crops with water maintained standing in the field, throughout the vegetative growth period, by irrigation, while the winter crop at Pattambi is grown, as a "dry" crop with no irrigation. Thus, for the winter crop at Pattambi, rainfall is the only source of water, while in the case of autumn crop at Aduthurai and the crop at Coimbatore, rainfall is supplemented, very considerably, by irrigation. Hence, the yield of the winter crop at Pattambi is very much lower than those for the autumn crop at Aduthurai and the winter crop at Coimbatore.

The highest and the lowest weekly values of each of the meteorological elements (Tables 4, 5 and 6) separately for each of the above three groups of stations and for each crop periods, is given in Table 7.

It will be seen from the values given in Table 7 that normally at no time, bright sunshine falls below 20 hrs per week, maximum temperature exceed 35°C and minimum temperature falls below 15°C. Thus sunshine and temperature do not appear to be limiting weather factors for the rice crop in India, so that the out-turn of the crop is dependent very greatly on the rainfall including its amount and distribution in time. About 65 per cent of the total precipitation of India is received as rainfall during the southwest monsoon season, from June to September, of which 50 per cent is received during July and August. In many countries, July and August are as hot as or hotter than June. It is not so in India because of the cloud and rains of the southwest monsoon. Thus India is fortunate that the bulk of its rainfall is received at a period when other climatological factors are not unfavourable, enabling the Indian farmers to make the maximum possible use of the water received as rainfall during the southwest monsoon season.

### 5. Summary and conclusion

In this contribution, crop and weather data being collected under the Co-ordinated Crop Weather Scheme are presented in terms of the average. The progress of the climatological elements, week by week, during the crop season is shown in the crop climatogram (Fig. 2). Information is presented about the average rice crop and average climatic features of the crop season together with their variabilities from year to year, as assessed from the crop weather data collected so far. It has been shown and explained that—

(*i*) There is a remarkable consistency in the average lengths (weeks) of the reproductive period of the crops as compared to the vegetative period,

(*ii*) The average date of flowering of the autumn rice crop at different stations is greatly dependent upon the geographical co-ordinates of the stations and

(*iii*) Pattambi stands out as an interesting station in the following ways — (*a*) for the autumn crop, in contrast to the autumn crop at other stations, the average date of flowering is later than can be expected, on the basis of the geographical

**TABLE 6**

**Climatology — Reproductive period**

| Climatic elements (mean per week) | Autumn crop | | | | | | Winter crop | | |
|---|---|---|---|---|---|---|---|---|---|
| | Chinsurah | Labhandi | Karjat | Samalkota | Aduthurai | Pattambi | Aduthurai | Coimbatore | Pattambi |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) |
| Rainfall (mm) | 7 | 5 | 27 | 29 | 31 | 52 | 12 | 6 | 0 |
| | (251) | (201) | (181) | (132) | (96) | (107) | (175) | (247) | (0) |
| Rainy days | 0 | 0 | 1 | 1 | 2 | 2 | 1 | 0 | 0 |
| | (0) | (0) | (125) | (90) | (78) | (74) | (147) | (0) | (0) |
| Bright sunshine (hrs) | 62 | 61 | 57 | 53 | 52 | 43 | 55 | 57 | 67 |
| | (19) | (13) | (23) | (27) | (21) | (29) | (19) | (20) | (9) |
| Mean daily max. temp. (°C) | 28·5 | 29·5 | 33·2 | 30·5 | 32·4 | 30·8 | 28·4 | 29·2 | 34·8 |
| | (3) | (3) | (3) | (3) | (2) | (3) | (2) | (2) | (2) |
| Mean daily min. temp. (°C) | 15·7 | 17·1 | 21·2 | 22·2 | 24·1 | 23·1 | 20·4 | 18·3 | 21·6 |
| | (7) | (9) | (4) | (4) | (1) | (2) | (3) | (4) | (3) |

Note—Figures within brackets represent the coefficients of variability

**TABLE 7**

**Climatology — Highest and lowest values**

| Climatic elements (mean per week) | Group I stations | | | Group II stations | | | Group III stations | | |
|---|---|---|---|---|---|---|---|---|---|
| | Seedling period | Vegetative period | Reproductive period | Seedling period | Vegetative period | Reproductive period | Seedling period | Vegetative period | Reproductive period |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) |
| Rainfall (mm) | 202 | 210 | 52 | 72 | 51 | 29 | 47 | 24 | 31 |
| | 158 | 80 | 27 | 21 | 41 | 5 | 11 | 17 | 0 |
| Rainy days | 7 | 6 | 2 | 4 | 3 | 1 | 2 | 1 | 2 |
| | 5 | 4 | 1 | 1 | 2 | 0 | 1 | 1 | 0 |
| Bright sunshine (hrs) | 28 | 30 | 57 | 49 | 48 | 62 | 46 | 62 | 67 |
| | 22 | 20 | 43 | 24 | 36 | 53 | 37 | 47 | 52 |
| Mean daily max. temp. (°C) | 33·1 | 31·6 | 33·2 | 34·6 | 31·8 | 30·5 | 35·0 | 33·2 | 34·8 |
| | 31·3 | 29·2 | 30·8 | 30·7 | 30·7 | 28·4 | 30·5 | 30·6 | 29·2 |
| Mean daily min. temp. (°C) | 25·3 | 23·6 | 23·1 | 26·2 | 25·3 | 22·2 | 25·7 | 24·9 | 24·1 |
| | 23·2 | 22·9 | 21·2 | 24·3 | 23·2 | 15·7 | 22·3 | 21·1 | 18·3 |

co-ordinates and the variability from season to season of the span of crop life is the least and (*b*) for the winter crop, the yield is the lowest of all the stations considered in the paper.

## 6. Acknowledgement

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