551·588·6(54)

A note on phenological observations in India

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(*Received 24 July 1963*)

ABSTRACT. The phenological organization and observational programme in India are described in the paper. Phenological data pertaining to mango and neem are discussed. Both the trees flower during winter and the flowering commences not from the extreme tip of the peninsula as might be expected but round about latitude 15°N. mango starting on the east coast and neem on the west coast. In both trees it takes about 10 weeks for the flowering to reach the foot of the Himalayas, broadly in conformity with Hopkins' 'Bioclimatic Law'. The practical uses of the study of phenology and the need to expand the phenological programme are pointed out.

1. Introduction

The influence of climate on plants is conspicuous. Animal life too is intimately related to climate. Migration and hybernation of animals are influenced by climatic factors. Phenology is the science which deals with the recurrence of periodical phenomena in plant and animal life in relation to the march of the seasons. The climatic conditions of a tract are reflected in the average dates on which plants enter their various phytophases like leafing, flowering, fruiting, etc. The dates of manifestation of phytophases constitute an integral of climatic effects as they take into account the weather over past periods and also the weather at the moment.

Smith (1938) concluded after a study of phenological data collected in the British Isles that flowering was affected by temperature. Higher than normal temperatures cause plants to flower early. From a study of phenological data, Dr. A. D. Hopkins of United States, formulated his 'Bioclimatic Law' which states that other conditions being equal, the date of appearance of a periodical phenomenon is delayed by 4 days for every degree of latitude towards the pole.

2. Organization and observational programme

Systematic recording of phenological observations began in India in 1952 and a network of about 200 phenological stations was organized on the initiative of the Agricultural Meteorology Division at Poona. The network consists of Agricultural Farms, Soil Conservation Centres and Meteorological Stations. Detailed instructions for phenological observations were prepared and supplied to all phenological correspondents. Forms for recording and reporting observations are also supplied to the stations. The observations are recorded on one or more of the following four trees—

Mango (Mangifera indica Linn), Neem (Azadirachta indica A. Juss. Syn Melia Azadirachta Linn), Tamarind (Tamarindus indica Linn) and Babul (Acacia arabica Willd. Syn Mimosa arabica Lam).

The phenological observations comprise of the determination of the dates of occurrence of the following phytophases—flowering, fruiting and maturity of fruits. The date of appearance of the very first flowers is taken as the date of flowering. Date of fruiting is the date of fruit-set, however small it may be. Maturity or ripening of fruit is usually accompanied with marked colour change. Phenological observations are made every fortnight and an estimate given of the actual date if it falls between two inspections.

3. Material and method

The phenological data, collected from the various stations are tabulated and plotted. The mean dates of occurrence of each of the

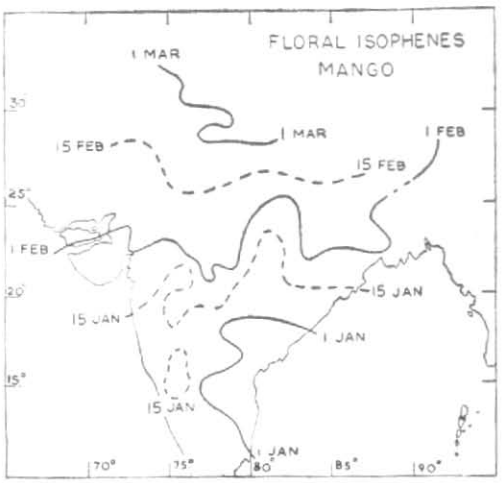
FLORAL ISOPHENES
MANGO
1 MAR
1 MAR
15 FEB
15 FEB
1 FEB
1 FEB
15 JAN
15 JAN
1 JAN
15 JAN
1 JAN
35°
25°
20°
15°
70°
75°
80°
85°
90°

Fig. 1

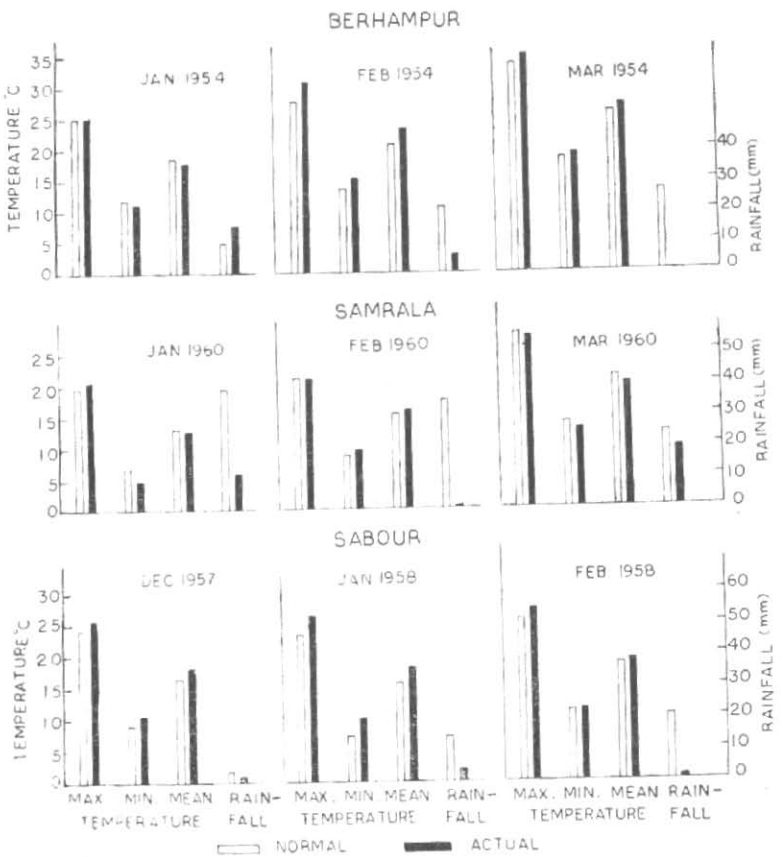
BERHAMPUR
JAN 1954
FEB 1954
MAR 1954
SAMRALA
JAN 1960
FEB 1960
MAR 1960
SABOUR
DEC 1957
JAN 1958
FEB 1958
TEMPERATURE °C
RAINFALL (mm)
MAX. TEMPERATURE
MIN. TEMPERATURE
MEAN TEMPERATURE
RAIN-FALL
NORMAL
ACTUAL

Fig. 2

phytophases are picked up from the graphs, charted on maps and isophenes drawn. Isophenes are lines which join together all the stations at which a given phytophase takes place at the same time. In order to get a general picture, a study is made using data of stations for which observations are available for at least 5 years. In this note, phenological data pertaining to mango and neem trees are discussed utilising available data of 150 and 140 stations respectively.

4. Isophenes of mango and neem

Fig. 1 shows the isophenes of flowering of mango. Flowering starts late in December in coastal Andhra Pradesh and adjoining areas, in January in the rest of South India and in February in most of north India. In the extreme north mango flowers only early in March.

It is interesting to note the association between rainfall and the date of flowering of the mango tree in the following instances. In 1958, the mango flowered at Chianki, Sabour and Pusa (all in Bihar State) about a month earlier than normal. Similarly in 1960, it flowered at Samrala (Punjab I) and Nahan (Himachal Pradesh) about a fortnight earlier than normal. On the other hand in 1954 mango flowered at Chinsurah, Berhampur, Midnapur and Krishnagar (all in West Bengal) about a fortnight later than normal. The corresponding weather conditions during flowering at Sabour, Samrala and Berhampur are shown in Fig. 2. The highly deficient rainfall in the months January and February 1958 at Sabour and in January and February 1960 at Samrala and the above normal rainfall in the month of January 1954 at Berhampur (the wet weather synchronised with the normal time and flowering, *i.e.*, 22 January) may be noted. In the above cases, the flowering of mango tree appears to have advanced in the years of low rains and receded in the years when the normal flowering time is immediately preceded by or synchronised with wet weather.

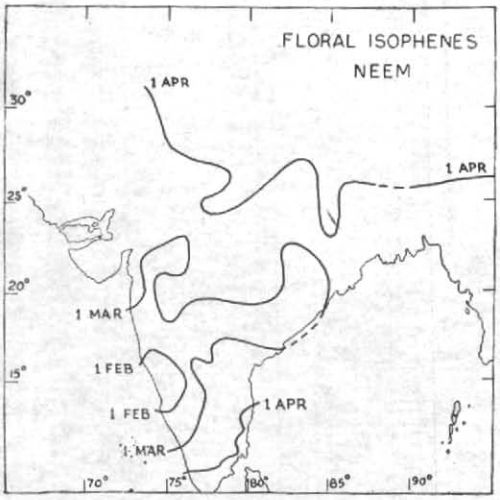

Fig. 3

Fig. 3 shows the isophenes of flowering of neem. Flowering in neem commences earliest in the middle of the west coast and proceeds thereafter in northeasterly and in southeasterly directions.

The pattern of isophenes of fruiting of both mango and neem follow more or less that of floral isophenes but with a natural lag of about a month.

Both mango and neem flower during the cold season. The flowering does not start from the tip of the peninsula as may be expected. It is interesting to note that both the trees commence flowering round about latitude 15°N, mango starting on the east coast and neem on the west coast. In this connection it will be interesting to see the monthly sunshine maps. Anna Mani *et al.* (1962) have presented maps showing the average duration of bright sunshine per day for each of the twelve months of the year. It is seen that during the cold season, November to February, the duration of sunshine is maximum in the Indian peninsula to the south of the Gangetic plains and to the north of latitude 13°N. It appears that the

TABLE 1

Station	Latitude (N)	Longitude (E)	Mean date of flowering	
			Tamarind	Babul
Tocklai	26°47′	94°12′	1 Jun	..
Lembuchera	23 50	91 17	15 Jun	..
Radhakishorpur	23 32	91 30	10 Jun	..
Mayanaguri	26 30	88 40	25 May	..
Krishnagar	23 20	88 30	2 Jun	..
Balangir	20 40	83 25	4 May	5 Jul
Kanke	23 20	85 15	10 May	..
Chianki	24 00	84 00	..	1 Jul
Pusa	25 55	85 40	25 May	10 Jun
New Delhi	28 35	77 12	12 Jun	..
Allahabad	25 27	81 44	5 Jun	..
Agra	27 10	78 02	1 Jun	..
Shahjahanpur	27 53	79 54	12 May	..
Saharanpur	29 58	77 33	6 Jun	..
Kalai	27 53	78 04	..	20 Jul
Ambala	30 23	76 46	..	1 Jun
Beas	31 30	75 15	..	5 Apr
Samrala	30 50	76 10	..	10 Sep
Ajmer	26 27	74 37	1 Jun	..
Barmer	26 45	71 23	..	10 Jun
Bikaner	28 00	73 18	..	1 Sep
Ganganagar	29 55	73 53	..	10 Oct
Udaipur	24 35	73 42	..	20 Jul
Adhartal	23 10	79 25	7 Jul	..
Bhilsa	23 30	77 45	..	20 Jul
Bagartawa	22 38	77 59	20 Jun	5 Jul
Biaora	23 55	76 50	1 Jun	1 Jul
Champa	22 00	82 40	5 Jun	1 Jul
Gwalior	26 13	78 14	15 Jun	..
Indore	22 43	75 48	3 Jun	1 Jul
Jabalpur	23 10	79 57	15 Jun	..
Labhandi	21 10	81 40	20 Jun	20 Jul
Mahagarh	24 20	75 05	8 Jun	10 Jul
Neemuch	24 28	74 54	2 Jun	..
Pendra Road	22 46	81 54	10 Jun	15 Jun
Powarkhera	22 40	77 40	15 Jun	15 Jul

TABLE 1 (*contd*)

Station	Latitude (N)	Longitude (E)	Mean date of flowering	
			Tamarind	Babul
Ratlam	23°19′	75°03′	25 May	..
Seopurkalan	25 40	75 41	..	1 Aug
Halvad	23 00	71 10	..	5 Jul
Jagudan	23 30	72 25	20 May	..
Navagaun	22 25	73 30	5 Jun	10 Jul
Porbundur	21 35	69 35	28 Apr	..
Sakkarbag	21 25	70 05	25 May	..
Surat	21 10	72 50	22 May	20 Jun
Viramgam	23 05	72 00	20 Jun	..
Achalpur	21 16	77 33	10 Jul	31 Jul
Akola	20 42	77 02	20 Jun	10 Jun
Akluj	17 50	75 00	..	1 Jun
Aurangabad	19 50	75 20	20 May	20 Jun
Badnapur	19 50	75 40	15 May	20 Jun
Boragaon	17 30	74 10	1 May	2 May
Chas	19 45	74 05	1 Jun	20 Aug
Deolali	19 50	73 50	25 May	15 Jun
Dhulia	20 50	74 45	..	20 Aug
Jalgaon	20 25	75 30	10 May	3 Jul
Jeur	17 15	75 45	20 May	15 Jun
Kolhapur	14 42	74 14	31 May	5 Jun
Kopargaon	19 50	74 25	5 Jun	8 Jun
Lakhmapur	20 30	74 20	15 May	..
Latur	18 20	76 30	10 May	22 May
Manjri	19 25	73 35	..	1 Jun
Mohol	17 45	75 35	15 May	27 Jun
Nagpur	21 05	79 05	15 Jun	15 Jul
Nanded	19 05	77 15	20 May	5 Jul
Niphad	20 05	74 05	20 May	..
Panvel	18 55	73 05	1 Jun	..
Padegaon	18 05	74 10	10 May	20 May
Parbhani	19 00	76 00	25 May	15 Jun
Ratnagiri	16 55	73 15	20 May	..
Sholapur	17 40	75 50	5 Jun	2 Jul
Vadgaon	18 50	73 10	10 May	15 May
Wanori	18 30	73 53	22 May	1 Jun

TABLE 1 (*contd*)

Station	Latitude (N)	Longitude (E)	Mean date of flowering: Tamarind	Mean date of flowering: Babul
Washin	20°05′	77°05′	..	20 Jul
Amberpet	17 20	78 20	5 May	20 Jun
Lam	16 20	80 25	25 Jun	..
Mudhol	18 55	77 50	10 May	1 Jun
Nandyal	15 28	78 31	15 Jun	..
Rajendranagar	17 20	78 20	10 Jun	10 Jul
Samalkot	17 00	82 05	1 Jun	25 Apr
Aduthurai	11 00	79 30	15 Jun	5 Jun
Coimbatore	11 00	76 50	25 Apr	1 Jun
Gudiyattam	12 55	78 50	8 Jun	20 Apr
Kovilpatti	09 12	77 53	6 Jun	..
Palur	11 45	79 35	10 Jul	..
Tindivanam	12 14	79 42	13 Jun	10 Jul
Tirukuppam	13 00	80 00	20 Jul	25 Jun
Bagalkot	16 10	75 40	8 May	1 May
Bellary	15 05	76 55	28 May	..
Bijapur	16 45	75 49	..	1 Jun
Chickanahalli	12 25	76 45	12 Apr	1 Jun
Devihosur	14 45	75 15	10 Jun	28 May
Dadhesugar	15 40	76 50	30 May	10 Jul
Hagari	15 05	77 00	25 May	15 Jun
Hiriyur	13 57	76 38	20 Apr	5 Jun
Kotekar	12 45	74 57	15 May	..
Mandya	12 30	76 50	15 Apr	1 Jun
Mangalore	12 52	75 00	10 May	..
Mugad	15 25	74 55	25 Apr	..
Nagenhalli	12 50	77 05	5 Apr	10 Jun
Naipni	16 20	74 20	20 May	10 Jun
Raichur	16 10	77 20	..	15 Jul
Sirugappa	15 35	76 50	10 May	1 Jun
Kasaragod	12 30	75 00	5 May	..
Kayamkulam	09 45	76 31	1 May	..
Pattambi	10 48	76 12	10 Apr	..
Taliparamba	12 00	75 20	25 May	..
Ollukkara	10 30	76 10	3 Apr	..

comparatively greater number of hours of bright sunshine in this area during these month is responsible for the earlier commencement of flowering around the 15°N latitude zone. It is also interesting to note that in both trees it takes about 10 weeks for the flowering to reach the foot of the Himalayas. Broadly speaking, the sequence of the dates of flowering is in conformity with Hopkins' 'Bioclimatic Law'.

In the case of tamarind and babul, the numbers of stations for which data for at least 5 years are available are only about 90 and 70 respectively and no systematic isophene pattern could be drawn in their cases. The average dates of flowering of tamarind and babul trees are given in Table 1.

A more detailed study on the subject to find out the relation between the flowering dates and the meteorological elements related to flowering is in progress.

5. Concluding remarks

A knowledge of average phenologic dates finds many important practical applications. Many uses of phenological observations are described by Ramdas and Mallik (1953). In the production of crops, phenological information is of considerable importance. The fruit trade will be considerably helped by a knowledge of the dates of maturity of fruits in different parts of the country which would help in the proper planning of the flow of the produce to the big markets. The same holds good in respect of other agricultural commodities. In planning forest fire protection it is important to know when the foliage is green and when the ground is covered with dried leaves due to leaf-shedding.

There are only about 200 phenological stations. The number of stations is admittedly insufficient for our country. It is also desirable that phenological observations on at least 20 to 30 trees are made so that the phenological charts will have wider use. In addition phenological observations on some common forest trees would be helpful

in estimating the degree of susceptibility of the forest to fire.

No systematic observations on animal phenology has so far been made in India. A beginning may be made by observing the first day of the singing of the cuckoo and the first day of the appearance of the dragon fly.

6. Acknowledgements

The authors are extremely grateful to Shri M. Gangopadhyaya, Director of Agricultural Metecrology, for suggesting the study and to Shri P. S. Harihara Ayyar, Meteorologist, for his keen interest.

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