Mausam, (1990), **41**, 4, 555-560

551.586 : 632.11

Agroclimatic charts for the cropping season in Bijapur area of Karnataka State

E. V. MURALI MOHAN RAO
University of Agricultural Sciences, Bangalore
and
N. B. K. REDDY
S. V. University, Tirupathi

(*Received 20 April 1989*)

सार— इस अध्ययन में, साप्ताहिक विभव वाष्पन-वाष्पोत्सर्जन और साप्ताहिक नमी उपलब्धता अवधि के आधार पर बीजापुर (कर्नाटक) के कृषि जलवायु संबंधी चार्ट तैयार किए गए हैं और सतही, मध्यम, गहन मृदा वायुमंडलीय स्थितियों के लिए फसल लगाने की संभव प्रणालियों को सुझाया गया है।

ABSTRACT. On the basis of weekly potential evapotranspiration and weekly moisture availability periods agroclimatic charts of Bijapur (Karnataka) are prepared and possible cropping systems for shallow, medium and deep soil climatic conditions are suggested in this paper.

1. Introduction

Low and highly unstable crop production are the two chief characteristic features of agriculture in arid tropics. Though these areas receive abundant solar energy, it is the randomly distributed and insufficient rainfall that results in undependable crop production. The economic value of rainfall of these areas depends upon the climatic factors that control evapotranspiration. A sound knowledge of the agroclimatic conditions of these areas is a pre-requisite for developing suitable agricultural technology. It is in this context, the present study pertaining to the agroclimatological survey of a place situated in the arid zone of Karnataka is undertaken.

1.1. *Area description and climatic conditions*

Bijapur (16° 49′ N, 75° 43′ E) situated in the arid zone of northern Karnataka is characterised by hot summer, mild winter and short and unrealiable rainy season. April and May are the hottest months. During the course of a year, the mean maximum temperature varies from 29°C in December to 39° C in May and the mean minimum temperature varies from 15°C in December to 24°C in April and May months. About 65 per cent of the annual normal rainfall of 575 mm is received during the four months of the southwest monsoon season and about 21 per cent of the annual total is received during October and November. A pronounced dry period extends from December to May. The highest rainfall is received during middle of September to middle of October and the average number of rainy days per week seldom exceed two.

2. Data and analysis

From the daily rainfall data (1945-1979) of Bijapur observatory, weekly average rainfall and average number of rainy days were calculated. From the point of view of availability of moisture to crops, a day was considered to be a rainy day if at least 5 mm of rainfall was recorded during that day. The weekly maximum limit of rainfall expected at 75 per cent probability level were calculated using the incomplete gamma distribution. The weekly potential evapotranspiration (PET) corresponding to the standard weeks defined by the India Meteorological Department (given in the agroclimatic charts) was estimated for the period 1965 to 1979 using Penman (1948) formula after incorporating the modifications suggested by Doorenbos and Pruitt (1977) and Ganesan (1970).

Of the several methods proposed for determining the growing period, the method proposed by Cocheme and Franquin (1967) is found to give satisfactory results in the study area. Therefore, it is adopted in the present study for determining the humid and moist periods.

For determining the area that comes under the influence of the meteorological observatory raingauge at Bijapur, Thiessen (1911) network was constructed by locating the surrounding raingauge stations on a map and drawing the perpendicular bisectors to the lines connecting the stations. The entire area (333 sq km) within the polygon is taken as the effective raingauge area. The soils of Bijapur area were surveyed

TABLE 1

Agroclimatic chart for shallow soils of Bijapur area

(Maximum available water=50 mm)

Agroclimatic parameter	Standard weeks (Dates)														
	22 (28 May -3 Jun)	23 (4- 10 Jun)	24 (11- 17 Jun)	25 (18- 24 Jun)	26 (25 Jun -1 Jul)	27 (2- 8 Jul)	28 (9- 15 Jul)	29 (16- 22 Jul)	30 (23- 29 Jul)	31 (30 Jul- -5 Aug)	32 (6- 12 Aug)	33 (13- 19 Aug)	34 (20- 26 Aug)	35 (27 Aug -2 Sep)	36 (3 -9 Sep)
(1) PET (mm)	46	41	39	38	34	34	38	34	31	32	34	34	32	32	36
(2) Average rainfall (mm)	17	28	15	20	16	13	11	21	36	24	14	17	26	27	22
(3) Probability of exceeding average rainfall (%)	32	35	37	32	68	39	36	34	32	31	33	22	8	31	27
(4) Average No. of rainy days	1	1	1	1	1	1	1	1	2	1	1	1	1	1	1
(5) Probability of a week being moist (%)	20	47	53	33	33	67	47	67	73	67	60	53	60	80	60
(6) Probability of a week being humid (%)	7	40	20	7	27	47	27	47	47	47	33	40	53	60	27
(7) Weather hazards	——————————Undependable rainfall frequent dry spells——————————														

TABLE 1 (*Contd.*)

Agroclimatic parameter	Standard weeks (Dates)													
	37 (10- 16 Sep)	38 (17- 23 Sep)	39 (24- 30 Sep)	40 (1- 7 Oct)	41 (8- 14 Oct)	42 (15- 21 Oct)	43 (22- 28 Oct)	44 (29 Oct- 4 Nov)	45 (5- 11 Nov)	46 (12- 18 Nov)	47 (19- 25 Nov)	48 (26 Nov- 2 Dec)	49 (3- 9 Dec)	50 (10- 16 Dec)
(1) PET (mm)	34	27	27	28	34	30	28	28	27	26	25	23	22	20
(2) Average rainfall (mm)	20	60	47	36	33	20	23	20	11	4	4	4	1	1
(3) Probability of exceeding average rainfall (%)	34	40	67	69	15	32	27	27	23	22	21	22	15	10
(4) Average No. of rainy days	1	2	2	2	1	1	1	1	1	—	—	—	—	—
(5) Probability of a week being moist (%)	67	80	93	87	73	87	87	67	53	47	27	27	13	13
(6) Probability of a week being humid (%)	47	73	87	80	73	73	53	47	47	27	7	20	13	13
(7) Weather hazards	——Frequent dry spells——													

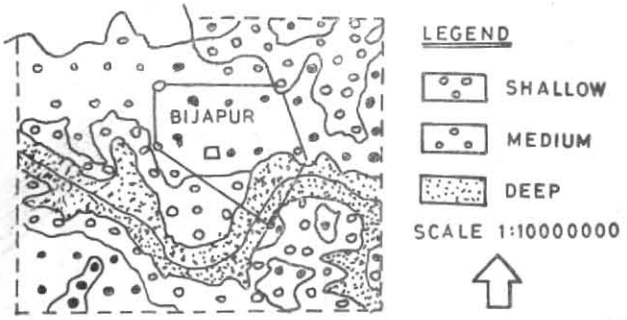

Fig. 1. Soil types of the study area

by remote sensing by the soil survey of the Department of Agriculture, Government of Karnataka (Mirajkar and Shamacharya 1980). The soil types present within the effective raingauge area were determined by superimposing the boundaries of the area on soil map of the region (Fig. 1).

The weekly amounts of moisture stored in the soil were estimated for each year of the period 1965-1979 by using the water balance technique (Thornthwaite and Mather 1955) for shallow, medium and deep basaltic soils present within the study area. The available soil moisture values of 50, 150 and 300 mm are found to be reasonable values respectively for shallow, medium and deep soils. Therefore, these values were considered for the study of water balance.

Moisture availability periods in different soils were determined by comparing the weekly rainfall plus moisture stored in root zone with weekly potential evapotranspiration by adopting the method of Cocheme and Franquin (1967). Smoothed curves of rainfall plus moisture stored in the root zone (R), PET, PET/2 and PET/4 were drawn for each year. The points of intersection where $R = \text{PET}$ define the limits of humid period (H). Similarly, the points of intersection where $R = \text{PET}/2$, $R = \text{PET}/4$ give the limits of moist (m) and moderately dry (M, D) periods. As the humid and moist periods represent the stress-free periods conducive to crop growth, only these two periods were determined for the place under study.

All the above computed climatological data were presented in the form of agroclimatological charts (Tables 1, 2 & 3).

3. Discussion

Even though Bijapur receives less rainfall which is highly variable and unevenly distributed, agriculture is practiced since the soils in the area are mostly black cotton soils which are highly moisture retentive in character. A major portion of the area under study is covered by shallow soils (Fig. 1). Wherever the land of shallow soil is rough, broken and stony with steep slopes, it is unfit for cultivation (Mirajkar and Shamacharya 1980). In such areas aforestation and development of pasture lands may be tried.

From the analysis of moisture availability periods in shallow soils (Table 1), it is found that in 67 per cent of the years, moist periods begin from 29th week (16-22 July) and in 53 per cent of the years the moist period ends in the 45th week. This condition will continue up to 10th of December. In 73 per cent of the years, humid period starts from 38th week (17-23 September), and extends up to 43rd week (22-28 October) in 53 per cent of the years. At the beginning of the moist period, the actual evapotranspiration of a partly covered bare soil is supposed to be one half of PET (Cocheme and Franquin 1967). Hence, water ceases to be a limiting factor for plant growth during this period. Sowing in shallow soils around Bijapur can be done after the 2nd week of July in 67 per cent of the years provided about 150-200 mm of well distributed rainfall is received during May, June and July months prior to sowing. Also, the land should be prepared well in advance of sowing preferably immediately after receiving initial rains. This will improve the infiltration of rainwater into the soil. However, if long dry spells occur after sowing, rainwater stored in farm ponds may be used for the purpose of crop saving protective irrigation.

In the light of the above discussion on the agroclimatic conditions present in the shallow soils of the study area around Bijapur, the following recommendations are made :

(*i*) Only monocropping system is possible in the shallow soils of Bijapur area.

(*ii*) Drought resistant crops like bajra, pulses and groundnut can be grown by adopting dry farming technology.

The second largest portion of the area around Bijapur is covered by medium soils. These calcareous, cracking clay soils have 1 to 5 per cent slope and are moderately eroded (Mirajkar and Shamacharya 1980). These soils are shallow to moderately deep with a depth varying from 22 cm to 45 cm and their colour varies from brown to very dark brown. With regards to the agroclimatological chart of the medium soils around Bijapur (Table 2), high probabilities for occurrence of moist periods are maintained from 29th week (16-22 July) onwards (Table 1) reaching 100 per cent during 39th and 40th weeks (24-30 September to 1-7 October) and is more than 60 per cent up to 4th week (22-28 January). The probabilities of occurrence of humid period between 38th week and 1st week (17-23 September to 1-7 January) are consistently high (Tables 1 and 2). Hence, in the medium soils of the area, the crop growing season starts from about middle of July (29th week) and extends up to the 4th week of January. In this land, crops like jowar, bajra, wheat, groundnut, safflower, redgram, blackgram, greengram, horsegram, tobacco and chillies can be grown under rainfed conditions. In view of the bimodel nature of the rainfall in this area and in view of the long growing season of about 190 days, the possibility of growing crops during *Kharif* and *Rabi* seasons may be explored.

TABLE 2

Agroclimatic chart for medium soils of Bijapur area

(Maximum available water=150 mm)

Agroclimatic parameter	Standard weeks (Dates)																	
	22 28 (May -3 Jun)	23 (4- 10 Jun)	24 (11- 17 Jun)	25 (18- 24 Jun)	26 (25 Jun -1 Jul)	27 (2- 8 Jul)	28 (9- 15 Jul)	29 (16- 22 Jul)	30 (23- 29 Jul)	31 (30 Jul -5 Aug)	32 (6- 12 Aug)	33 (13- 19 Aug)	34 (20- 26 Aug)	35 (27 Aug -2 Sep)	36 (3- 9 Sep)	37 (10- 16 Sep)	38 (17- 23 Sep)	39 (24- 30 Sep)
(1) PET (mm)	46	41	39	38	34	34	38	34	31	32	34	34	32	32	36	34	27	27
(2) Average rainfall (mm)	17	28	15	20	16	13	11	21	36	24	14	17	26	27	22	20	60	47
(3) Probability of exceeding average rainfall (%)	32	35	37	32	68	39	36	34	32	31	33	22	8	31	27	34	40	67
(4) Average No. of rainy days	1	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1	2	2
(5) Probability of a week being moist	27	53	47	33	40	67	53	80	87	87	87	87	93	93	93	93	93	100
(6) Probability of a week being humid	6	33	13	27	40	47	40	73	67	67	60	53	67	73	80	73	80	93
(7) Weather hazards	— — — — — — — —Undependable rainfall frequent dry spells— — — — — —																	

TABLE 2 (*Contd.*)

Agroclimatic parameter	Standard weeks (Dates)																	
	40 (1- 7 Oct)	41 (8- 14 Oct)	42 (15- 21 Oct)	43 (22- 28 Oct)	44 (29 Oct- 4 Nov)	45 (5- 11 Nov)	46 (12- 18 Nov)	47 (19- 25 Nov)	48 (26 Nov- 2 Dec)	49 (3- 9 Dec)	50 (10- 16 Dec)	51 (17- 23 Dec)	52 (24- 31 Dec)	1 (1- 7 Jan)	2 (8- 14 Jan)	3 (15- 21 Jan)	4 (22- 28 Jan)	5 (29 Jan- 4 Feb)
(1) PET (mm)	28	34	30	28	28	27	26	25	23	22	20	24	23	25	26	27	29	29
(2) Average rainfall (mm)	36	33	20	23	20	11	4	4	4	1	1	1	—	—	—	—	—	—
(3) Probability of exceeding average rainfall (%)	69	15	32	27	27	23	22	21	22	15	10	—	—	—	—	—	—	—
(4) Average No. of rainy days	2	1	1	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—
(5) Probability of a week being moist	100	93	93	93	93	93	87	87	87	87	93	87	80	80	80	73	60	40
(6) Probability of a week being humid	100	80	80	80	87	87	87	80	87	80	87	73	73	67	40	27	6	13
(7) Weather hazards	— — —Frequent dry spells— — —																	

TABLE 3

Agroclimatic chart for deep soils of Bijapur area

(Maximum available water=300 mm)

Agroclimatic parameter	Standard weeks (Dates)																						
	22 (28 May-3 June)	23 (4-10 Jun)	24 (11-17 Jun)	25 (18-24 Jun)	26 (25 Jun-1 Jul)	27 (2-8 Jul)	28 (9-15 Jul)	29 (16-22 Jul)	30 (23-29 Jul)	31 (30 Jul-5 Aug)	32 (6-12 Aug)	33 (13-19 Aug)	34 (20-26 Aug)	35 (27 Aug-2 Sep)	36 ((3-9 Sep)	37 (10-16 Sep)	38 (17-23 Sep)	39 (24-30 Sep)	40 (1-7 Oct)	41 (8-14 Oct)	42 (15-21 Oct)	43 (22-28 Oct)	44 (29 Oct-4 Nov)
(1) PET (mm)	46	41	39	38	34	34	38	34	31	32	34	34	32	32	36	34	27	27	28	34	30	28	28
(2) Average rainfall (mm)	17	28	15	20	16	13	11	21	36	24	14	17	26	27	22	20	60	47	36	33	20	23	20
(3) Probability of exceeding average rainfall (%)	32	35	37	32	68	39	36	34	32	31	33	22	8	31	27	34	40	67	69	15	32	27	27
(4) Average No. of rainy days	1	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1	2	2	2	1	1	1	1
(5) Probability of a week being moist	27	60	67	60	73	73	67	80	93	87	93	87	93	93	100	100	100	100	100	100	93	93	100
(6) Probability of a week being humid	13	40	27	40	53	53	53	73	80	80	87	80	87	93	93	100	100	93	100	93	93	93	100
(7) Weather hazards	——————Undependable rainfall								——————Frequent dry spells										——Frequent dry spells——				

TABLE 3 (*Contd.*)

Agroclimatic parameter	Standard weeks (Dates)																						
	45 (5-11 Nov)	46 (12-18 Nov)	47 (19-25 Nov)	48 (26 Nov-2 Dec)	49 (3-9 Dec)	50 (10-16 Dec)	51 (17-23 Dec)	52 (24-31 Dec)	1 (1-7 Jan)	2 (8-14 Jan)	3 (15-21 Jan)	4 (22-28 Jan)	5 (29 Jan-4 Feb)	6 (5-11 Feb)	7 (12-18 Feb)	8 (19-25 Feb)	9 (26 Feb-4 Mar)	10 (5-11 Mar)	11 (12-18 Mar)	12 (19-25 Mar)	13 (26 Mar-1 Apr)	14 (2-8 Apr)
(1) PET (mm)	27	26	25	23	22	20	24	23	25	26	27	29	29	53	36	36	40	41	42	43	45	46
(2) Average rainfall (mm)	11	4	4	4	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
(3) Probability of exceeding average rainfall (%)	23	22	21	22	15	10	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
(4) Average No. of rainy days	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
(5) Probability of a week being moist	100	100	100	100	100	100	100	100	100	100	100	100	93	87	87	87	80	80	80	75	67	67
(6) Probability of a week being humid	100	93	93	93	93	93	93	87	87	87	87	80	80	80	80	80	67	53	40	33	20	—
(7) Weather hazards	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

The third type of soil occupying a small portion of the region is the deep basaltic soils. Land occupied by this soil is mostly flat to gently slopping. This is a deep dark greyish, calcareous, deep to very deep soil, with depths more than 45 cm. Like medium black soils, these deep clay soils also develop cracks in summer. The starting of moist and humid period in these soils is the same as in the case of shallow and medium soils (Table 1), while the moist period extends up to the 2nd week of April, the humid period extends up to the first week of March in 67 per cent of the years. Mainly, crops like jowar and safflower can be grown in *Rabi* season in these soils.

References

Cocheme, J. and Franquin, P., 1967, 'An agroclimatic survey of a Semi-arid area in Africa South of the Sahara, WMO Tech. Note No. 86.

Doorenbos, J. and Pruitt, W.O., 1975, Crop Water requirements : Irrigation and Drainage, paper 24 F.A.O. Rome, pp. 11-23.

Ganesan, H., 1970, 'Estimation of Solar Radiation over India', *Indian J. Met. Geophys.*, **21**, pp. 629-636.

Mirajkar, M.A. and Shamacharya, K., 1980, 'Soil Map of Bijapur District', Report of the Soil Survey Organisation of Karnataka State, Department of Agriculture, Bangalore, pp. 1-11.

Penman, H.L., 1948, Natural Evaporation from Open Water Bare Soil and Grass, Proceedings Royal Society Series-A Vol. 193, pp. 120-145.

Thiessen, A.H., 1911, 'Precipitation Averages for Large Areas,' *Mon. Weath. Rev.*, **39**, pp. 1082-1084.

Thornthwaite, C.W. and Mather, J.R., 1955, *The Water balance*, *Publications in Climatology*, Laboratory of Climatology, Vol. **8**, pp. 1-104.