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AGROCLIMATOLOGY OF RAYALASEEMA

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ABSTRACT

This paper deals with some aspects of agroclimatology of Rayalaseema region, the southern part of Andhra Pradesh. Climatic features of the region are discussed briefly. An attempt has been made to classify areas of rice growing potential in the region. This study shows that the whole region is not favourable for rainfed cultivation of rice crop except Srikalahasti in Chitoor district, where it can be grown as rainfed crop in rabi season. The agro-ecological zonation of the region is presented with a view for the development of rainfed agriculture. The distribution of Index of Moisture Adequacy is studied for Kharif and Rabi seasons along with the cropping pattern. It can be concluded that the area under paddy may be decreased in the region during Kharif and Rabi seasons where irrigation facilities are not available and the area under Jowar and pulses may be increased. Water availability periods have been computed according to the methods of Cocheme and Franquin, Krishnan. It is observed that the humid period is less in the region and hence it is appropriate to go for short duration varieties to prevent the crops from undergoing water stress. The accumulated PE, PE/2 and AE during the crop growing season under water balance diagrams to significant agricultural drought years to Jowar, Bajra and Groundnut are presented.

Key-words : Agroclimatology, Rayalaseema.

INTRODUCTION

The Rayalaseema region constitutes the Southern part of Andhra Pradesh comprising four districts viz. Anantapur, Chittoor, Cuddapah and Kurnool (Fig. 1). Most of the region is an undulating country dotted with ridges and clusters of rocky hills, part of which falls within the range of the Eastern Ghats. No high mountain ranges, no thick forests, the paucity of perennial rivers, a low rainfall, an enurvating climate — these are the characteristics that nature has given to this land and no wonder that its material progress is hampered. This region is known for long as the stalking ground of famines and it is declared as Famine zone of South India. Lying almost in the southern part of peninsula, the area comes within the influence of both monsoons — Southwest and Northeast — but does not get the full force of either as they often reach it only after the strength is exhausted. Hence, the frequent failure of one or the other result in scarcity of food, fodder and employment. The variability of the rainfall in this region profoundly influences the agriculture which is the main-stay of the economy of the peasant dry land farmers. In a region like Rayalaseema handicapped by the natural disadvantages, an intensive and continuous research base is essential. Hence, an agro-climatic study of this region is carried out to provide comprehensive

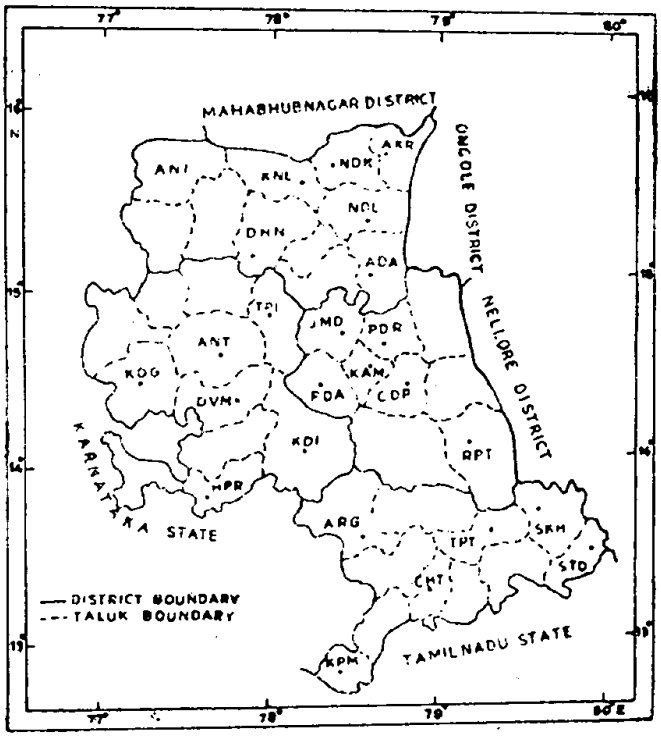

Fig. 1. Stations location chart.
ANI-Adoni, KNL-Kurnool, NDK-Nandikotkur, AKR-Atmakur, DHN-Dhone, NDL-Nandyal, ADA-Allagadda, KDG-Kalyandurg, ANT-Anantapur, DVM-Dharmavaram, TPI-Tadipatri, HPR-Hindupur, KDI-Kadiri, JMD-Jammalamadugu, PDR-Proddutur, KAM-Kamalapuram, CDP-Cuddapah, PDA-Pulivendla, RPT-Rajampeta, TPT-Tirupati, SKH-Srikalahasti, STD-Satyavedu, CHT-Chittoor, ARG-Arogyavaram, KPM-Kuppam.

information on the natural resources of the region and to be of help in planning for improvement of the agricultural economy of the region. In this paper, a net work of thirteen stations maintained by India Meteorological Department, Agrometeorological and Agricultural departments having rainfall and temperature data has been used. Apart from this, data of 12 rain gauge stations has also been utilised.

Climatic features :

The principal climatic factors affecting crop production are temperature, rainfall, wind and relative humidity. These factors have been discussed briefly to have a better understanding of the climate of the region.

In Rayalaseema region, temperature is not a limiting factor for crop husbandary as its variation is not significant and it is above the conventionally accepted threshold temperature of 6 °C (Schimber 1903). The distribution of mean annual, kharif, Rabi and summer temperatures over the region is shown in Fig. 2. Temperature decreases from Southeast to Southwest in all the sea-

sons. Temperature in excess of 29°C is observed in the Southeastern part of the region. The lowest temperature recorded in the region is 25.1 °C at Arogyavaram in Chittoor district which is a health resort centre in the state. Temperature is higher in kharif season than in rabi season.

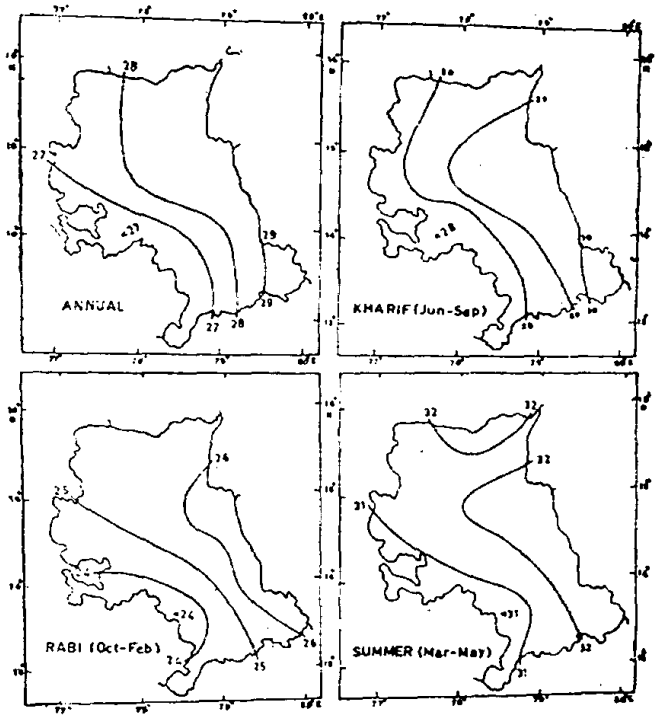

Fig. 2. Map showing mean air temperatures (°C)

The Rayalaseema region has an average rainfall of 620 mm with a low dependability and is subjected to recurring famines. The isohyets drawn for mean annual, kharif, rabi and summer rainfall in the region is shown in Fig. 3. The mean annual rainfall increases from west to southeast. The whole of Anantapur district receives rainfall less than 600 mm. Western parts of Kurnool and Cuddapah districts receive 600–700 mm of rainfall. The Southeastern parts of Chittoor district and eastern parts of Cuddapah district receive rainfall more in rabi season than in kharif season. The lowest rainfall is 520 mm at Kalyandurg in Anantapur district and the highest is 1106 mm at Srikalahasti in Chittoor district. The mean annual winds are higher in Anantapur district (12.3 km per hour) and lower in Cuddapah district (8.7 km per hour). The winds during kharif season are higher than in rabi and summer seasons in the region. The period from February to May is the driest part of the year in the region. During this period, the relative humidity is 50 to 60% in the morning and 20 — 30% in the afternoons. Humidity is high in the Southwest and Northeast monsoon seasons being 70 to 80% in the morning and 40 to 50% in the afternoons.

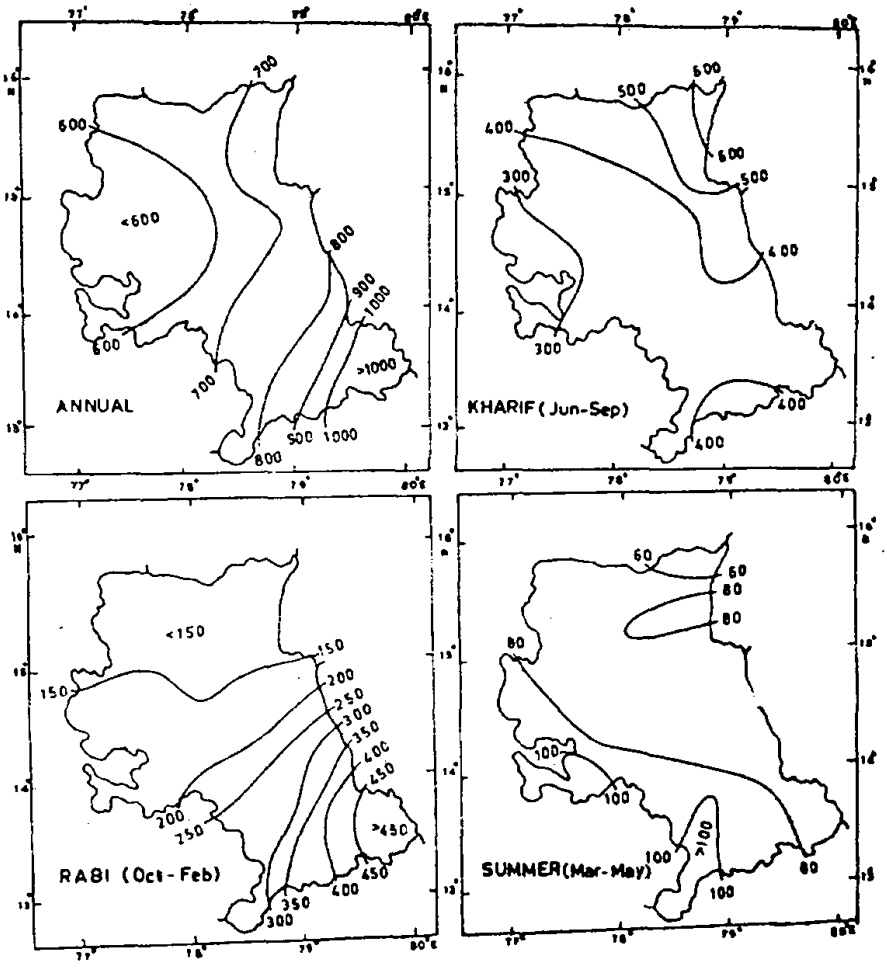

Fig. 3. Map showing normal rainfall (mm)

Classification for rice growing potential:

According to the report of working group on establishment of South-east Asian Cropping system test sites, different climatic zones are delineated by grouping the available information on rainfall. The first criterion used for selecting major climatic zones was monthly rainfall. An arbitrary boundary was set up at 200 mm. This amount is based on the following assumptions.

i. Losses due to evapotranspiration although variable over the year, generally amount to be around 100 mm per month.

ii. Losses due to percolation and seepage although variable depending on soil characteristics, are generally around 100 mm per month.

The second criterion taken for grouping is the number of months with 200 mm or more rainfall. An arbitrary boundary was set as five to nine consecutive wet months. Based on this criteria four zones were deliniated. According to this classification, most of the area in Rayalaseema region comes

under zone IV (Zone IV is the areas with less than two consecutive wet months. These areas are not suitable for rice cultivation without any supplemental irrigation) except at Srikalahasti and Satyavedu in Chittor district where rice can be grown as rainfed crop in rabi season. The remaining part of the region is not favourable for rainfed cultivation of rice crop.

Agro-Ecological Zones :

Panabokke (1979) had given an interesting classification for delineating agro-ecological zones of South and South-east Asia. According to him, an agro-ecological zone is a major area of land that is broadly homogeneous in respect of its rainfall regime and is made up of grouping of soils that reflect broad similarities in respect of soil profile development. The rainfall regimes are divided according to the annual frequential rainfall patterns of their seasonalities and amounts that could be grouped into agronomically significant categories. He categorised six rainfall regimes and seven soil groupings. The soil regions were demarcated and set of overlays at the same scale and these were then superimposed on the rainfall regime maps.

Since rainfall alone never reflects the moisture status of a region, Subramaniam (1983) suggested the agro-ecological zoning utilising the concept of moisture adequacy index (ratio of AE/PE), in the place of rainfall. He classified the moisture adequacy (MA) into six regimes. According to this classification, five major agro-ecological zones are identified in the region (Fig. 4). These are $MA_5\ S_4$, $MA_5\ S_5$, $MA_4\ S_4$, $MA_3\ SA_4$ and $MA_6\ S_4$ where MA_3, MA_4 and MA_5 are moisture adequacy regimes and S_4, S_5 refers to the soil zones of types vertisoils and alfisoils. Based on this classification, the following agronomic grouping could be made in the region.

Group 2: Mainly irrigated rice crop during wet season followed by arable crops during dry or cool seasons.
$MA_2\ S_5$, $MA_3\ S_4$, $MA_3\ S_5$, $MA_3\ S_6$, $MA_5\ S_5$ (rice, pulses, ragi, groundnut)

Group 4: Mainly rainfed dry crops with moderate drought stress
$MA_2\ S_6$, $MA_4\ S_4$, $MA_4\ S_5$, $MA_4\ S_6$, $MA_5\ S_4$, $MA_5\ S_5$, $MA_5\ S_6$ (bajra, jowar, ragi, cotton)

Group 5: Mainly rainfed dry crops with moderate to high stress
$MA_6\ S_4$, $MA_6\ S_5$ (jowar, sunflower, safflower, castor)

It can be seen from the figure 4 that Anantapur district falls under $MA_6\ S_5$. Some parts in Kurnool district area under $MA_5\ S_4$. The whole of Cuddapah district and some parts in Kurnool district is occupied by the zone $MA_5\ S_4$. except Arogyavaram which is under $MA_3\ S_5$. The approach suggested by Subramaniam (1983) will have greater role as the moisture factor and its distribution is a major ecological factor for plant growth in the tropical conditions.

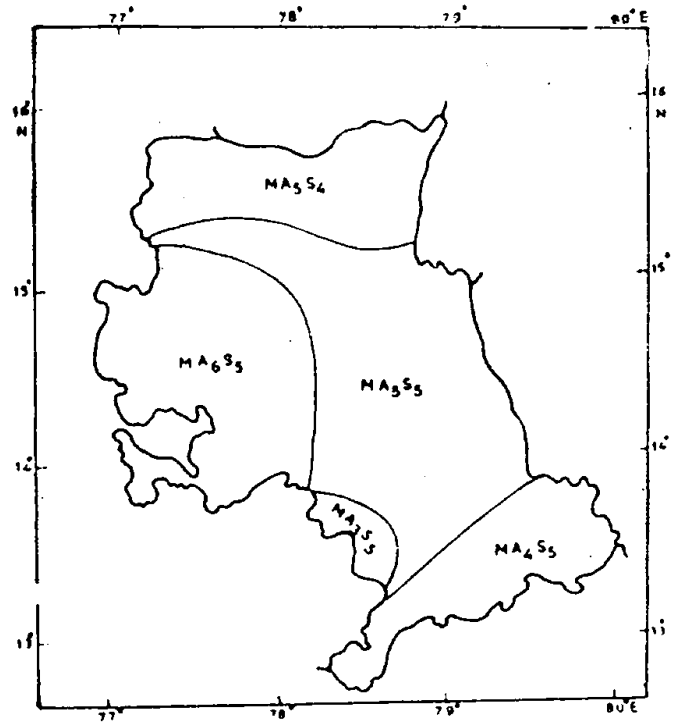

Fig. 4. Map showing Agro-ecological zones (After Subramaniam)

Moisture adequacy and cropping pattern :

The moisture adequacy index, I_{ma} is defined as the ratio between actual evapotranspiration (AE) and Potential evapotranspiration (PE) expressed as percentage. This gives the the actual water supply that has taken place in the form of evapotranspiration to the potential need and thus gives the moisture potential of the area. Since the moisture is the limiting factor in the tropical regions, this index which relates the moisture availability to the moisture demand is an useful tool for determination of crop distribution and estimation of irrigation scheduling. The distribution of index of moisture adequacy in the region during annual, kharif, rabi and summer seasons is presented in Fig. 5. In kharif season I_{ma} ranges from 50 to 65% in the whole region except in the Northeastern part covering Nandyal and Allagadda in Kurnool district where it is 75%. During rabi season, it ranges from less than 30% in the whole of Kurnool district and parts of Anantapur district to greater than 80% at Srikalahasti in Chittoor district.

Low percentage of the moisture adequacy indicates poor moisture availability. Subrahmanyam, Subha Rao and Subramaniam (1963) reported optimal values for efficient growth and development of crops. According to them, for sufficient growth and development of paddy 80 to 100% of I_{ma} values is required below which the yield would be reduced considerably. Similarly

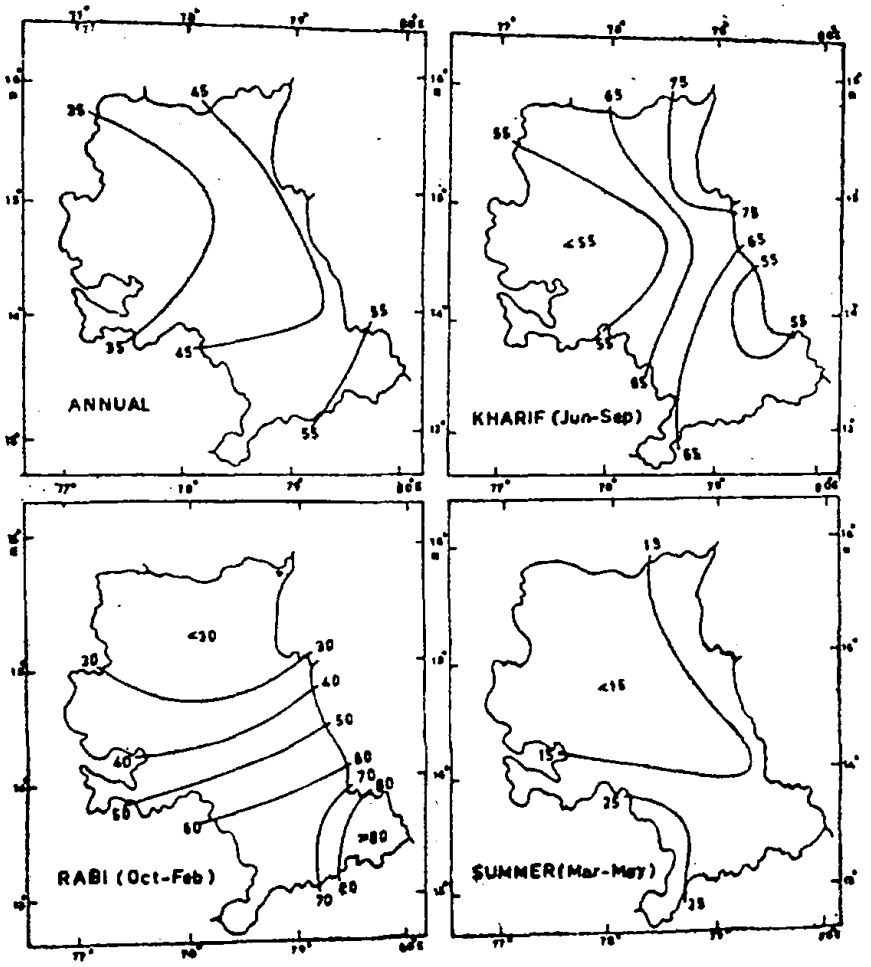

Fig. 5. Map showing index of moisture adequacy (%)

for millets, the value of I_{ma} ranging between 40 to 60% is required. For a detailed understanding of area under different crops in relation to moisture adequacy, the seasonal distribution of moisture adequacy is superimposed on cropping pattern and the following conclusions have been drawn. During kharif season I_{ma} value ranges from 50 to 75%. It is advisable to grow paddy where irrigation facilities are available. Especially in the western part of the region representing Anantapur district, it is recommended that instead of rice, other crops like pulses, jowar, bajra, groundnut may be grown under safe limits without irrigation. During rabi season, it is recommended that rice may be grown in the Southeastern part of the region covering Srikalahasti and Satyavedu taluks in Chittoor districts without irrigation facilities. In Kurnool and Anantapur districts, kharif season is more suitable than the rabi season for growing crops like jowar, bajra and groundnut etc.

Water availability periods :

The potential productivity of the region depends upon available water

resources in addition to other factors such as soil fertility, terrain etc. Especially for rainfed crops, water availability depends upon rainfall. The length of water availability periods helps to assess the forming season in a rational manner. They also serve as guide for optimal use by a suitable selection of

Table I. Period and number of days under sub-humid period I, humid period and sub-humid period II at different stations in Rayalaseema (After Krishnan)

Station	Sub-humid period I (PE/2 < AE > PE/4)	Humid period (AE > PE/2)	Sub-humid period II (PE/2 < AE > PE/4)	Total number of days
1. Allagadda	9th April to 23rd May (45 days)	24th May to 18th October (144 days)	19th October to 9th November (21 days)	210 days
2. Anantapur	9th May to 2nd August (84 days)	3rd August to 15th October (72 days)	13th October to 9th November (26 days)	180 days
3. Arogyavaram	12th April to 11th June (60 days)	12th June to 12th December (180 days)	13th December to 30th January (58 days)	298 days
4. Chittoor	9th April to 20th June (72 days)	21st June to 18th December (177 days)	19th December to 9th January (21 days)	270 days
5. Cuddapah	6th May to 5th June (30 days)	6th June to 12th November (156 days)	13th November to 30th November (18 days)	204 days
6. Dharmavaram	9th May to 2nd August (84 days)	3rd August to 15th October (72 days)	16th October to 15th November (30 days)	186 days
7. Kurnool	21st April to 2nd June (42 days)	3rd June to 9th October (126 days)	10th October to 9th November (30 days)	198 days
8. Nandyal	18th April to 23rd May (36 days)	24th May to 3rd October (129 days)	4th October to 9th November (36 days)	201 days
9. Proddutur	27th April to 14th June (48 days)	15th June to 9th October (114 days)	10th October to 12th November (33 days)	198 days
10. Rajampeta	15th May to 17th June (33 days)	18th June to 6th December (168 days)	7th December to 15th December (9 days)	210 days
11. Srikalahasti	15th April to 11th June (57 days)	12th June to 30th January (228 days)	31st January to 3rd March (33 days)	318 days
12. Tadipatri	1st May to 20th July (81 days)	21st July to 6th October (75 days)	7th October to 6th November (30 days)	186 days
13. Tirupati	21st April to 17th June (57 days)	18th June to 21st December (183 days)	22nd December to 21st January (30 days)	270 days

crop varieties and agronomic practices. Hence, in an area, the availability of water with regard to both timing and quantity is by far the most important factor controlling crop production. The water availability periods for Rayalaseema region have been computed according to the methods of Cocheme & Franquin (1967) and Krishnan (1968). From Tables I and II it can be seen

Table II. Period and number of days under moist period I, humid period and moist period II at different stations in Rayalaseema (After Cocheme and Franquin).

Station	Moist Period I (PE/2 < P > PE/4)	Humid period (P > PE/2)	Moist Period II (PE/2 < P > PE/4)	Total number of days
1. Allagadda	9th April to 23rd May (45 days)	24th May to 1st October (144 days)	19th October to 9th November (21 days)	210 days
2. Anantapur	9th May to 31st July (82 days)	1st August to 12th October (72 days)	13th October to 9th November (26 days)	180 days
3. Arogyavaram	12th April to 11th June (60 days)	12th June to 3rd December (171 days)	4th December to 18th December (15 days)	246 days
4. Chittoor	21st April to 23rd June (63 days)	24th June to 6th December (162 days)	7th December to 15th December (9 days)	234 days
5. Cuddapah	6th May to 5th June (30 days)	6th June to 12th November (156 days)	13th November to 30th November (18 days)	204 days
6. Dharmavaram	9th May to 2nd August (84 days)	3rd August to 15th October (72 days)	16th October to 15th November (30 days)	186 days
7. Kurnool	21st April to 2nd June (42 days)	3rd June to 9th October (126 days)	10th October to 9th November (30 days)	198 days
8. Nandyal	18th April to 23rd May (36 days)	24th May to 3rd October (129 days)	4th October to 9th November (36 days)	201 days
9. Proddutur	27th April to 14th June (48 days)	15th June to 9th October (114 days)	10th October to 12th November (33 days)	198 days
10. Rajampeta	15th May to 17th June (33 days)	18th December 6th December (168 days)	7th December to 15th December (9 days)	210 days
11. Srikalahasti	18th April to 5th June (48 days)	6th June to 15th December (189 days)	16th December to 21st January (36 days)	273 days
12. Tadipatri	1st May to 20th July (81 days)	21st July to 6th October (75 days)	7th October to 6th November (30 days)	186 days
13. Tirupati	27th April to 8th June (42 days)	9th June to 9th December (180 days)	10th December to 18th December (9 days)	231 days

that the number of water availability days according to these authors are the same at all the stations in the region except at Arogyavaram, Chittoor, Srikalahasti and Tirupati where they are more according to Krishnan. The number of water availability days varies from 180 at Anantapur in the western part of the region to 243 at Srikalahasti in Southeastern part of the region. It can be seen that the total number of water availability days are less in Anantapur district and are more in Chittoor district. The humid period is the period in which the actual evapotranspiration is in excess of half of the potential evapotranspiration and this period is suitable for grand growth of any crop. This study indicates that though water availability period starts early in a region, the grand growth period (humid period) is less except in Chittoor district. From this study it may be said that the sowing dates can be adjusted so that the grand growth and development phases of crops can be fallen during the period in such a way that the agricultural production may be increased in the rainfed cultivated areas and also suggests that it is appropriate to go for short duration varieties in the region to prevent the crops from undergoing stress.

Water balance and agricultural droughts:

For precise understanding of the agricultural drought problems of a crop in a region, we must know the critical growth period of the crop and its water need at the stage. Hence the accumulated PE, PE/2 and AE during the crop growing seasons and water balance diagrams to significant agricultural drought years for jowar, bajra and groundnut at Anantapur, Cuddapah, Chittoor and Kurnool are presented in Fig. 6. The aim of presenting this aspect is to understand how the water balance varies in a particular year if there is any significant drought. It is observed from the Fig. 6a that at Anantapur the accumulated AE line is always lower than the accumulated PE/2 line thereby indicating water stress conditions prevailed throughout the crop growing season. Hence, jowar, bajra and groundnut have undergone disastrous drought in the year 1962. It can be seen from the water balance diagram of Anantapur for the year 1962, that water deficiency is found throughout the year indicating that rainfall received at Anantapur has not met fully the water need of the crop. In Chittoor, 1972 was the disastrous drought year for jowar and bajra and large drought year for goundnut. Fig. 6 (b) shows that the accumulated AE line is above the accumulated PE/2 line during the first month of the growing season and later it is below the PE/2 line upto the middle of October. Water balance diagram for the year 1972 at Chittoor shows that there is an excess of rainfall in the months of October and November which is not useful for the growth and development of jowar and bajra since by that time grain filling stage was over.

It is also seen that the rainfall received during October and November might give some relief to groundnut as it is sown late in the region, that is why only large drought conditions prevailed in that year. The year 1972 was

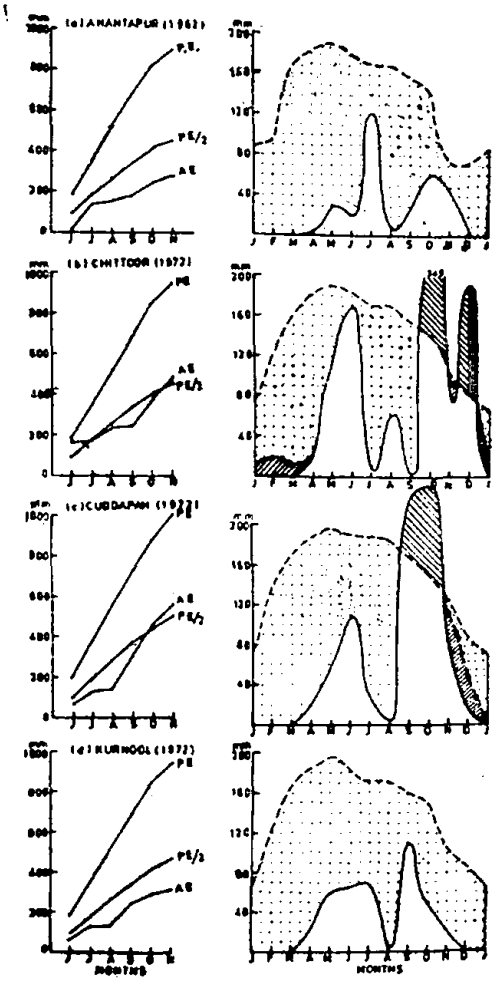

Fig. 6. Map showing accumulated PE, PE/2, AE for three crops during the growing season and water balances of significant agricultural drought years.

the disastrous drought year for jowar and bajra and moderate drought for groundnut at Cuddapah. From the figure 6 (c) it is seen that accumulated AE line is below the accumulated PE/2 line upto September. The rains received during September and October are not useful for jowar and bajra as a result they have undergone water stress and hence yield in that year was reduced. At Kurnool also 1972 was the disastrous year for jowar, bajra and groundnut. Fig. 6 (d) shows that accumulated AE line is always lower than accumulated PE/2 line throughout the crop growing season. Water balance diagram of Kurnool station shows that water deficiency is found throughout the year.

From this study it may be said that when accumulated evapotranspiration (AE) is below half of the water need (PE) throughout the growing season, disastrous drought conditions are witnessed for jowar and bajra at the four stations in the region and when accumulated AE exceeds half of the water need (PE) for atleast sometime during crop growing season, moderate to large drought conditions are experienced for groundnut.

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