GOVERNMENT OF INDIA
INDIA METEOROLOGICAL DEPARTMENT

MET MONOGRAPH AGRIMET NO. 17/2005

VARIABILITY OF SOWING DATES OVER ANDHRA PRADESH

INVESTGATION
AND
DEVELOPMENT UNIT

OFFICE OF THE
ADDITIONAL DIRECTOR GENERAL
OF METEOROLOGY (RESEARCH)
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PREFACE

Correct determination of sowing dates is one of the most crucial decisions in any agricultural operation. India Meteorological Department has therefore started providing on a scientific basis the detailed information on this particular aspect of climate for different states in the form of publications. The present publication in this series covers the state of Andhra Pradesh.

Based on long series of rainfall data, dates ideal for commencing sowing operations in Andhra Pradesh are computed. 260 raingauge stations, representing nearly all climatic, soil and cropping zones in the state are selected. With the help of suitable rainfall criteria, the sowing dates are identified and their statistical properties are brought out. Furthermore, the areas liable to drought risk of various categories are demarcated by superimposing some of the results thus obtain on the soil map.

This publication brings out some information on agroclimatic aspects vital to agriculture, for example, (i) agricultural planning on rational and scientific basis, (ii) identifying the regions highly vulnerable to drought, (iii) formulating anti-drought measures and strategies and (iv) evolving a system of supplemented irrigation to dry land crops. It is hoped that the practicing agriculturists, planners and agricultural scientists will find the information useful.

This publication has been prepared by the Investigation and Development Unit of the Office of the Additional Director General of Meteorology (Research), Pune.

I take this opportunity to express my sincere thanks to Dr. K. C. Sinha Ray, Director (Retired), Shri A. K. Srivastava, Director, and Shri G.S. Bhujad, A.M.II (Retired) for analysis of the data, who worked under the guidance of Dr. U.S. De. Ex-ADGM(R) and Dr. H. R. Hatwar, ADGM(R) for constant encouragement.

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New Delhi
Date

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Director General of Meteorology

VARIABILITY OF SOWING DATES OVER ANDHRA PRADESH

ABSTRACT

In the present study, rainfall climatology of different regions of Andhra Pradesh has been worked out to find out approximate sowing dates (for different crops) for the different areas. These climatological sowing dates have been calculated from a long series of daily rainfall data.

The analysis reveals that, sowing rains over Andhra Pradesh start as early as 1 June in the eastern part of Adilabad district in North Andhra Pradesh and as late as around 1 September in Nellore district, the southernmost coastal district of the state. This late sowing dates in Nellore district could be attributed to the fact that the district gets major portion of rainfall from withdrawal phase of southwest monsoon and subsequent northeast monsoon. Therefore farmers of southwest Andhra Pradesh may have to go for irrigation for the sowing operations of the kharif crops rather than depending on natural rainfall.

Introduction

About 70% of the agriculture in the country is rainfed and 75% to 90% of the annual rainfall is received during southwest monsoon season, spanning over the four months from June to September. This is the main cropping season and the kharif crop is grown during the period. Sowing of kharif crops in any region, usually starts with the first monsoon rain. Preparation of field which takes a time is absolutely essential before the sowing operations begin. Therefore, an advance estimation of approximate date of sowing dates over an area would be of immense help to the farmers.

The objective of the present study is to give information to agricultural experts and planners on the most appropriate time of sowing of kharif crops in Andhra Pradesh. These climatological sowing dates have been calculated from a long series of daily rainfall data. Based on the soil characteristics, Andhra Pradesh has been divided into seven agro climatic zones. Rainfall requirement of sowing operations of different crops has been decided with the consultation of state agricultural authorities. Further, after the sowing, a relatively dry period is required for germination. Based on these requirements, a criterion is defined for identifying spells of rain at the beginning of the southwest monsoon season which would provide sufficient water to build up the required moisture reserve for each agro climatic zone. Based on such criteria and utilizing daily rainfall data for 83 years period from 1 May to 31 October in respect of 260 well distributed raingauge stations over the state; first probable dates satisfying the criteria have been worked out for Andhra Pradesh state. These dates together with related statistical parameters are presented in the study.

2. Physical Features:

Andhra Pradesh is the fifth largest state of the Indian Union covering an area of 2,75,069 sq.km. (INDIA , 2005). Geographically the State lies in the peninsula within latitudes $12^0$37'N to $19^0$54'N and longitudes $76^0$46' E to $84^0$46' E. The region is bound by Maharashtra, Chattisgarh, and Orissa on north; Karnataka towards west and Tamil Nadu on south, while towards the east, it has a long coastline of about 974 km facing the Bay of Bengal.

The State can be divided into the following three major physiographic regions:

(i) The coastal plain with average elevation varying from 0-150 metres, covering almost entire coastal Andhra with some of the best agricultural land of the State. This area falls between two major river deltas, Krishna and Godavari, and the soil is largely composed of riverine and coastal alluvium and in some places red loams.

(ii) Peninsular plateau also known as `Deccan Plateau' with average elevation varying from 150-600 metres covering almost the entire Rayalaseema and most parts of Telangana regions with more than half of the cultivated area of the State. The general terrain has a surface of red sandy soil with numerous hills and seasonal streams and tanks. The plateau generally has a slope towards the east.

(iii) Eastern ghats with average elevation 600 metres and above consisting of a series of broken hills and ridges covering about 13 per cent of the land area. These ghats are divided into two sections, viz., northern and southern ridges by a delta of about 120-140 km width in the middle.

The Andhra plateau is drained by three river systems, the Godavari, the Krishna and the Pennar. While the Godavari and the Krishna emanate from the Western Ghats in Maharashtra, the Pennar river originates over the Karnataka plateau. These rivers are generally rain-fed. The Godavari is one of the most important rivers, while the Krishna divides the peneplain into Telangana and Rayalaseema. River Pennar, along with its two tributaries Chitravati and Papaghni first flow in a northerly direction then takes a right turn towards the east.

The ruggedness of the topography of Andhra Plateau, the infertility of the soil and semi-arid climatic conditions are not best suited for the agriculture. Only about 40% of the total land in this region is under net sown area (Planning Atlas of Andhra Pradesh, 1976).

The rainfall in Rayalaseema is much less than that of Telangana. The northern and northeast margin of Telangana is constituted by the central Godavari valley, an area of faulted structure, thick forest cover and abundant rainfall.

To the south of central Godavari valley, lays the Telangana peneplain running up to Krishna valley in the south. The northern portion of this region is one of the best agricultural lands of Andhra Plateau. However, the southern parts, mostly covering Mahbubnagar and Nalgonda districts are not suited for good agriculture.

The coastal area of Andhra Pradesh consists of Srikakulam, Visakhapatnam, Vizianagaram, East and West Godavari, Krishna, Guntur, Prakasam and Nellore districts. The Godavari is the largest perenial river in peninsular India. The width of the river is over 3 km at Rajahmundry and about 6 km at Dowleshwaram. The Krishna is the second important river. Rainfall generally decreases from east coast to interior till it reaches Krishna-Godavari delta. In the east coastal belt itself, there is considerable variation in the rainfall distribution from the north to the south mainly due to the fact that northern Andhra Pradesh gets rainfall from south-west monsoon (78%) southward up to the Krishna delta, and rainfall over the southern parts of this region is decreased mainly because the region lies off the main track of the monsoon currents and associated depressions. To the further south, most of the rainfall is caused by retreating monsoon (44 to 60%) and during northeast monsoon season as the storms and depressions originating in the south Bay of Bengal gives copious rainfall during its course of movement and striking the coast.

The coastal plain has a very small percentage of land under forest cover mainly confined to the Srikakulam, Visakhapatnam and East and West Godavari districts.

The physical features of the state are depicted in Fig.1.

3. Irrigation Potential :

Canals and tanks on the lowland and wells on the highland form the chief source of irrigation. Coastal Andhra Pradesh is rich in water resources due to Godavari and the Krishna rivers. The Godavari mainly consists of three canals irrigating 0.33 million hectare area i.e. 70% of the total irrigated area. The coastal Andhra is irrigated by canals, however, a small percentage of area in Visakhapatnam, Srikakulam and Nellore disrticts are also irrigated by wells.

Important irrigation schemes implemented in the State include Nagarjunasagar project, Prakasam barrage, Sir Arthur Cotton barrage, Tungbhadra

low level canal, Kurnool-Cuddapah canal, Kadam project, Romperu drainage project and Upper Pennar project. Other important projects under implementation include Sri Ramsagar project, Vamsadhara project, Polavaram multi-purpose project and Somasila project. Telugu Ganga project has been launched in 1983 to irrigate Rayalaseema region and Nellore district.

4. Annual Rainfall:

There is a remarkable variability in the rainfall over the State. The annual rainfall over the State varies from less than 60 cm in western Rayalaseema to more than 100 cm in the north and northeastern parts of the state, and reaching 150 cm close to the northeastern border. Along the Eastern Ghats, running parallel to the coast, rainfall is generally more mainly due to orographic effects.

Moreover, a very significant variation in the rainfall occurs even for smaller area bound between districts Guntur, Nalgonda and Khammam represented by stations Repalle ($16^0$02'N, $80^0$51'E) with annual rainfall 972.8 mm; Bhongir ($17^0$31'N, $78^0$53'E) with annual rainfall 684.4 mm; and Nuguru ($18^0$20'N, $80^0$33'E) with annual rainfall 1481.5 mm respectively and have profound impact on the sowing operations.

The most parts of the state barring Telangana receive good amount of rainfall during the northeast monsoon season (October-December) also and in the southern coastal belt, comprising of Guntur, Prakasam and Nellore districts receives even upto 50 to 75 cm rainfall during this period.

5. Agroclimatic zones, cropping pattern and soils :

The state has been divided into seven agro climatic zones based on climate, topography, vegetation, type of soil and nature of crops (Fig. 2).

These agro climatic zones together with cropping pattern, type of soil and annual range of precipitation (average) is given in Table I.

A generalised soil map of Andhra Pradesh (Fig.3) shows the distribution of different soil categories. For the preparation of Table 1 and Fig. 3, the report of National Commission on Agriculture (1976) and National Atlas of India (1980) were consulted.

6. Selection of the criteria for the sowing rains:

Selection of area/crop specific sowing dates requires realization of a minimum amount of rainfall in a spell of few days so that there is sufficient moisture in the soil up to a reasonable depth even after evaporative losses. For this purpose, state agricultural authorities were consulted and following criteria for calculation of sowing dates for different agro climatic zones were adopted.

	Category of zone		Criteria
I.	Krishna-Godavari Zone	:	At least 25 mm of rain in a period of 2 days. Interspell duration should not exceed 7 days.
II.	North Coastal Zone	:	At least 30 mm of rain in a period of 3 days. Interspell duration should not exceed 7 days.
III.	Southern Zone	:	At least 25 mm of rain in a period of 2 days. Interspell duration should not exceed 7 days
IV.	Northern Telangana Zone	:	At least 20 mm of rain in a period of 2 days.
V.	Southern Telangana Zone	:	At least 50 mm of rain in a period of 7 days.
VI.	Scarce Rainfall Zone of Rayalaseema	:	For Anant hapur, at least 25 mm of rain in a spell of 3 days with in terspell duration not exceeding 10 days. For the rest of zone which consists of mixed red and black soil, crop wise criteria have been suggested as follows : Jowar – 50 mm rainfall in 7 days spell. Cotton – 70 mm rainfall in 7 days spell. Groundnut – 40 mm rainfall in 7 days spell.
VII.	High Altitude and Tribal Areas	:	40 mm of rain in a spell of 3 days with interspell duration not exceeding 5 days.

7. Database and method of analysis:

In the study, daily rainfall data from 260 rain gauge stations in the state, from 1 May to 31 October for 83-year period (1901-1983) have been considered. Stations having rainfall data for the period of 25 years or more are considered for calculation of the sowing dates. Distribution of these stations is shown in all the charts by dots. The distribution of stations with the period of data is depicted in Histogram (Fig.4).

The number of rain gauge stations varies from 4 in Warangal district to a maximum of 23 in Krishna district. Each rain gauge station, on an average, represents about 1058 sq.km. area and for nearly 41% of the stations, database exceeds even 75 years, 36% of the stations have the database between 25 to 34 years while only 3% of the stations have the data between 55 to 64 years.

The daily data for each of the stations for each year were examined for identifying the dates of Commencement of Sowing Rains (CSR) according to the criteria mentioned in section 6. The first date of the start of the first spell satisfying the criteria was determined for each year. This was done for all the years and for all the stations. From the dates thus obtained, the mean and the median sowing dates were worked out, plotted and analysed. Other statistical parameters including dispersion were also analysed.

8. Data presentation:

The following parameters were plotted on the map of Andhra Pradesh in $1 : 2 \times 10^6$ scale and analysed.

(i) Mean CSR dates (m)
(ii) Median CSR dates (mi)
(iii) Standard Deviation (S.D.)
(iv) Semi-Inter Quartile Range (SIQR) and
(v) Percentage frequency distribution of CSR dates, in respect of 13 selected stations (plotted on the graph).

The isopleths or isolines for mean and median are drawn at an interval of 5 days. The S.D. and SIQR have also been analysed at an interval of 5 days.

9. Results and discussion :

9.1 Mean dates for CSR

The spatial distribution of mean CSR dates is depicted in Fig.5. The isolines of mean CSR dates indicate that the sowing dates in the State start as early as around 1 June over a small pocket surrounding Chinnur tehsil in Adilabad district, a northern district of the State adjoining Maharashtra. The isolines reveal a southward progression in these dates. Here in isolines, a high gradient, i.e. a steep/sharp increase mainly due to remarkable variations in rainfall within a comparatively smaller areal distance bound by Nalgonda, Khammam and Guntur districts is noticed. This high gradient reveals that rainfall may not be very dependable for sowing operations mainly over these areas. The last sowing date of 1 September is seen over the areas of Iskapalle, Nellore and Sangam in Nellore district.

9.2 Median CSR dates

The spatial distribution of median CSR dates is shown in Fig. 6.

The isolines of median CSR dates indicate that according to the rainfall climatology the earliest sowing dates are around 1 June over northern parts of the State i.e. over some pockets of Adilabad, Karimnagar, Warangal and Khammam districts. The isolines progress southwards and after 5 June these show a high gradient. Last sowing dates around 15 September could be seen over central parts (with a western tilt) of Nellore district surrounding Udaygiri and Rapur tehsils.

On comparison with mean distribution chart, it can be said that both the parameters have displayed almost similar features. In both the cases, the climatological sowing dates commences as early as around 1 June over northern parts of the State i.e. Telangana region adjoining Maharashtra. Season progresses southwards and ends (i.e. latest sowing) in Nellore, a southern coastal district of the State with mean distribution chart showing last sowing dates as per rainfall climatology around 1 September while median chart indicates the same around 15 September.

The late sowing dates as per rainfall criteria in Nellore district, shown by mean/median distribution, could be attributed to the fact that the district gets major portion of rainfall from withdrawal phase of southwest monsoon and

Subsequent northeast monsoon (IMD Memoirs, 1962). South coastal Andhra Pradesh, of which Nellore district is a part, receives more rainfall during September and October mainly due to formation of systems in central and southern Bay of Bengal and retreating monsoon/setting in of northeast monsoon. Mean/median sowing dates (satisfying the occurrence of certain amount of rainfall in a spell) confirms this.

This is a climatic information to aid the planners and farmers, implying that if a farmer of southeast Andhra Pradesh desires to grow a crop like jowar or groundnut (usually sown in June and July) it is more likely that he has to depend on irrigation for the water requirements of sowing operations.

9.3 Variability of mean sowing dates

Variability of mean sowing dates has been represented by Standard Deviation (S.D.), which has been depicted in Fig.7. So far as entire State is concerned, variability of 15 days has been noticed over northern districts of Nizamabad and Adilabad adjoining Maharashtra State. S.D. goes on increasing westward as well as southward and a maximum of about 50 days variability is seen over southern districts of Ananthapur and Chittoor. S.D. Over Telangana region ranges between 15 days over Nizamabad and Adilabad districts. For Mahbubnagar and Nalgonda districts, it is 30 days whereas for Rayalaseema region variability ranges from 35 days over Kurnool to 50 days over Ananthapur and Chittoor districts and that over Coastal Andhra varies from 30 days over Srikakulam to 45 days over Prakasam and Nellore districts. This high variability over the said regions indicates that realization of rainfall during the southwest monsoon season is not very reliable for sowing operations and farmers have to adopt other means (i.e. irrigation) for sowing operations.

9.4 Semi-Inter Quartile Range

Spatial distribution of SIQR values represent central tendency of median CSR dates. In other words, dispersion on variability of median CSR dates has been represented by SIQR, which has been shown in Fig.8. Here, the northwestern portion of the State has least SIQR of 10 days, whereas southwestern portion has a maximum SIQR of 50 days. SIQR progresses southwards as well as eastwards. Gradient between isolines of SIQR is not found to be very much steep except along the southwestern portion where a slight steepness is reported.

Thus, the SIQR map portrays that the dispersion from median CSR date is less over northwestern parts of the State and it is maximum over southwestern region.

9.5 Frequency distribution of CSR dates

Percentage frequency distribution of CSR dates in respect of selected stations well spread over different agro climatic zones of Andhra Pradesh are depicted in Fig.9. Stations for which the analysis has been carried out are so chosen that each agro climatic zone has been represented by at least one station.

Krishna-Godavari zone has been represented by the Rentachintala station in Guntur district. Here, frequency distribution suggests that for sowing dates satisfying rainfall criteria lie between 20-30 July.

North Coastal zone has been represented by Kalingapatnam and Visakhapatnam. Frequency distribution in respect of Kalingapatnam is more or less even and the period 10-20 August appears to be the best period for depending on the rainfall for sowing operations. Whereas frequency distribution in respect of Visakhapatnam is more or less a bimodal showing two maxima indicating two different sowing periods viz., 10-20 June and 20 August to 10 September.

The Southern zone has been represented by the stations Nellore and Cuddapah. Frequency distribution in respect of Nellore is more or less negatively skewed suggesting that only during the later parts of the season; rainfall could be depended for sowing operations. In other words, kharif cropping may require irrigation for sowing operations. This is supported by the fact that Nellore gets more rains during October and November compared to other months of the year (IMD Memoirs, 1962). Frequency distribution in respect of Cuddapah shows single maxima during 20 to 30 July suggesting that this period is the most ideal for sowing as per rainfall climatology.

Northern Telangana zone has been represented by the stations viz., Adilabad, Karimnagar and Medak. The pattern of frequency distribution in respect of Adilabad is rather peculiar compared to those of other stations. The highest percentage frequency of 39.6 for Adilabad has been reported during 10 to 20 June suggesting that this period being the most ideal for sowing. While for Karimnagar,

the maximum frequencies are accumulated during 30 May to 30 June. Whereas for Medak, 30 May to 20 June is the most ideal for sowing.

Southern Telangana zone is represented by Hyderabad and Mahbubnagar. Frequency histogram in respect of Hyderabad is self explanatory. Hyderabad receives rains mostly from southwest monsoon and that too from the Arabian Sea branch indicating that the earlier phase of the rainy season i.e. 30 May to 30 June is ideal for sowing. Based on the same reasoning, 30 May to 30 June is the ideal sowing period for Mahbubnagar also.

Ananthapur represents the Scarce rainfall zone of Rayalaseema. The name itself indicates that the zone gets less rainfall during the rainy season. This may be seen in the frequency histogram, indicating that the most ideal dates for sowing operations lie between 10-20 September as per rainfall climatology and again here rainfall may be very reliable for sowing operations of kharif crops.

High Altitude and Tribal Areas of the State have been represented by the stations Bhadrachalam and Chintapalle. In both the cases the most ideal period for sowing is during 10-20 June. Though the maximum frequency is seen during 10-20 June for both the cases, in case of Chintapalle, maximum frequencies lie in the period ranging from 20 May to 10 July, while same for Bhadrachalam are from 1 May to 30 June during which sowing could be taken up.

10. Drought prone areas of the State:

Based on soil properties, annual rainfall, median sowing dates and its Semi-Inter Quartile Range; drought prone areas of Andhra Pradesh have been delineated.

For this purpose, maps depicting annual rainfall, median sowing dates and its Semi-Inter Quartile Range have been superimposed on soil map of the state. Due weightage has been given to the characteristics of soil (i.e. fertility). It may be mentioned that Alluvial and Black soils are more fertile than any other soils.

The above superimposition divides the state area into 5 different degrees of drought proneness ranging from very high to very low. It may be mentioned that the early sowing dates given by median chart coupled with sufficient rainfall and less Semi-Inter Quartile Range are indicators of better yield. Moreover, areas having

less Semi-Inter Quartile Range are likely to be less drought prone. Fig. 10 shows the state areas covered under different degrees of drought proneness. The results of the superimposition have also been put in a tabular form (Table II).

It may be seen that the most of the region of the state is moderately to highly drought prone except the coastal region and northern parts of the state adjoining Maharashtra.

11. Conclusions

The analysis revealed that from climatological standpoint, sowing dates over Andhra Pradesh start as early as around 1 June in northern region and as late as around 1-15 September in Nellore district.

Moreover, steep gradient in isolines over some parts of the state, due to very high variability of rainfall, is also noticed. It may be mentioned here that, natural rainfall may not be very dependable for sowing operations over such areas and need irrigation.

The geographical setting of the State results in a prolonged rainy season, even beyond 1 December in southeastern tehsils of Chittoor and Nellore districts adjoining Tamil Nadu. This extended rainy season over the State is due to withdrawal phase of southwest monsoon and subsequent northeast monsoon, which makes the sowing in Nellore district late.

Study also shows that the northern parts of the state adjoining Maharashtra and the coastal region are the least drought prone; where rainfall alone is sufficient for crop sustenance. Whereas in other parts, which are moderately to highly drought prone, supplementary irrigation is recommended.

TABLE – I
AGROCLIMATIC ZONES AND CROPPING PATTERN

	Category of zone	Coverage in terms of districts (tehsils)	Normal Annual Rainfall (cm)	Soil type	Cropping pattern (Major crops grown)
I.	Krishna - Godavari Zone	Krishna, Guntur, Prakasam (excluding Kanigiri, Kandukur, Gidalur and Markapur tehsils); East Godavari (excluding Chodavaram, Kakinada, Prathipadu, Pithapuram and Tuni tehsils); Khammam (Aswaraopeta, Madhira and Khammam tehsils); Nalgonda (Huzurnagar and Miryalguda tensils) and West Godavari.	80-110	(i) Alluvial : 47% (ii) Red sandy : 45% (iii) Black : 6% (iv) Mixed red and black : 2%	Paddy, Bajra, Millets, Groundnut, Other oilseeds and Pulses
II.	North Coastal Zone	Srikakulam, Vizianagaram (excluding Parvathipuram, Bobbili and Salur tehsils); Visakhapatnam (excluding Paderu and Chintapalle tehsils) and East Godavari (Kakinada, Pithapuram and Prathipadu tehsils).	105-115	(i) Red sandy : 80% (ii) Alluvial : 14% (iii) Laterite : 6%	Paddy, Groundnut, Other oilseeds and Pulses
III.	Southern Zone	Nellore, Chittoor, Prakasam (Kanigiri and Kandukur tehsils); Cuddapah (excluding Proddatur, Jammalamudugu and Pulivendla tehsils) and Ananthapur (Kadiri tehsil).	60-100	(i) Red sandy : 75% (ii) Alluvial : 10% (iii) Mixed red and black : 5% (iv) Skeletal : 4% (v) Red loamy : 4% (vi) Laterite : 2%	Paddy, Groundnut, Millets and Bajra
IV.	Northern Telangana Zone	Adilabad, Karimnagar, Nizamabad, Warangal (excluding Jangaon tehsils); Medak (excluding Sangareddy, Narsapur and Gajwel tehsils); and Khammam (excluding Bhadrachalam, Aswaraopeta, Madhira and Khammam tehsils).	95-120	(i) Red sandy : 60% (ii) Mixed red and black : 38% (iii) Skeletal : 2%	Paddy, Jowar, Groundnut and Pulses.
V.	Southern Telangana Zone	Hyderabad, Ranga Reddy, Nalgonda (excluding Huzurnagar and Miryalguda tehsils); Medak (Sangareddy, Narsapur and Gajwel tehsils); Warangal (Jangaon tehsil) and Mahbubnagar (excluding Kollapur and Alampur tehsils)	70-90	(i) Red sandy : 85% (ii) Black : 10% (iii) Mixed red and black : 4% (iv) Laterite : 1%	Paddy, Jowar, Oilseeds (including Groundnut) and Pulses

TABLE – I (contd…)

	Category of zone	Coverage in terms of districts (tehsils)	Normal Annual Rainfall (cm)	Soil type	Cropping pattern (Major crops grown)
VII.	High Altitude and Tribal Areas	Khammam (Konta and Bhadrachalam tehsils); East Godavari (Chodavaram tehsil); Visakhapatnam (Paderu and Chintapalle tehsils) and Vizianagaram (Parvathipuram, Bobbili and Salur tehsils).	105-120	(i) Red loamy : 75% (ii) Black : 20% (iii) Red sandy : 5%	Paddy, Bajra, Groundnut, Other oilseeds and Pulses.
VII.	High Altitude and Tribal Areas	Khammam (Konta and Bhadrachalam tehsils); East Godavari (Chodavaram tehsil); Visakhapatnam (Paderu and Chintapalle tehsils) and Vizianagaram (Parvathipuram, Bobbili and Salur tehsils).	105-120	(i) Red loamy : 75% (ii) Black : 20% (iii) Red sandy : 5%	Paddy, Bajra, Groundnut, Other oilseeds and Pulses.

TABLE II

Degree of drought proneness	Area covered
A : VERY LOW	Major portions of Nellore, Prakasam, Guntur, Krishna, East Godavari, West Godavari, Medak, Nizamabad, Adilabad, Karimnagar, Warangal, Khammam and Srikakulam districts. Small portions of Chittoor and Visakhapatnam districts. Very small portions of Mahbubnagar, Ranga Reddy and Vizianagaram districts.
B : LOW	Major portion of Mahbubnagar district. Small portions of Adilabad, Kurnool, Prakasam and Guntur districts.
C : MODERATE	Entire Hyderabad district. Most of the region of Nalgonda district. Major portions of Karimnagar, Nizamabad, Medak, Ranga Reddy, Mahbubnagar, Guntur, Khammam, Warangal, East Godavari, West Godavari, Krishna, Visakhapatnam, Vizianagaram, Srikakulam and Kurnool districts. Small portions of Cuddapah,Nellore,Prakasam and Ananthapur districts.
D : HIGH	Major portions of Ananthapur, Kurnool, Cuddapah, Chittoor, Nellore and Prakasam districts. Small portions of Medak and Ranga Reddy districts.
E : VERY HIGH	Small portions of Ananthapur, Chittoor and Prakasam districts. Very small portions of Srikakulam, Nellore, Visakhapatnam and East Godavari districts.

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LIST OF ILLUSTRATIONS

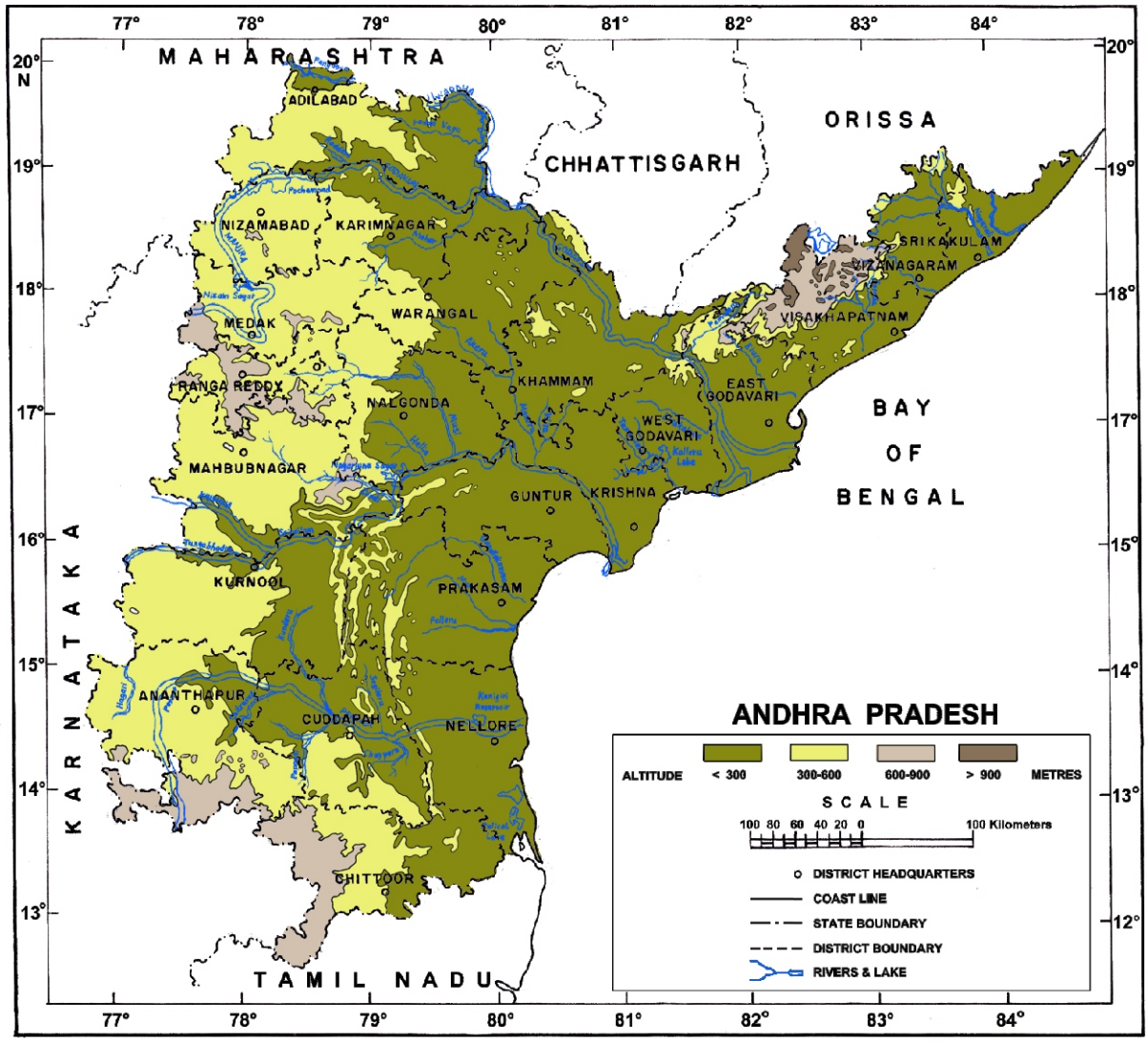
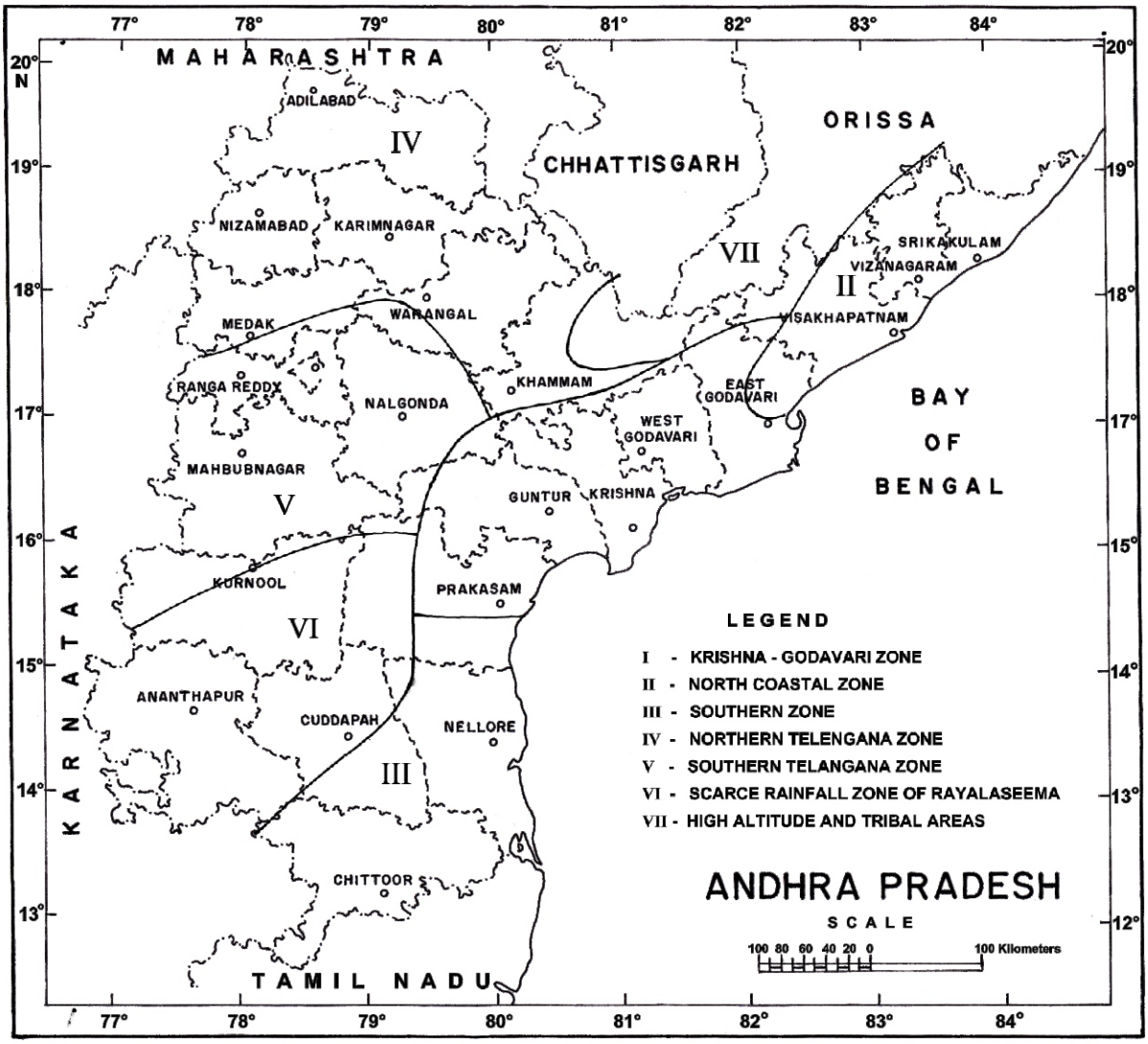


FIG. 1: ANDHRA PRADESH - PHYSICAL FEATURES



The coastlines of India agree with the record / Moster Copy certified by Survey of India. The teritorial waters of India extend into the sea to a distance of twelve nautical miles measured from the appropriate base line. The spellings of names in this map, have been taken from various sources. The resposibility for the correctness of intrenal details rests with the publisher.

FIG. 2: STATE MAP OF ANDHRA PRADESH WITH AGROCLIMATIC ZONES, (NUMBERS INDICATE DIFFERENT AGROCLIMATIC ZONES AND LINES THEIR DEMARCATION)

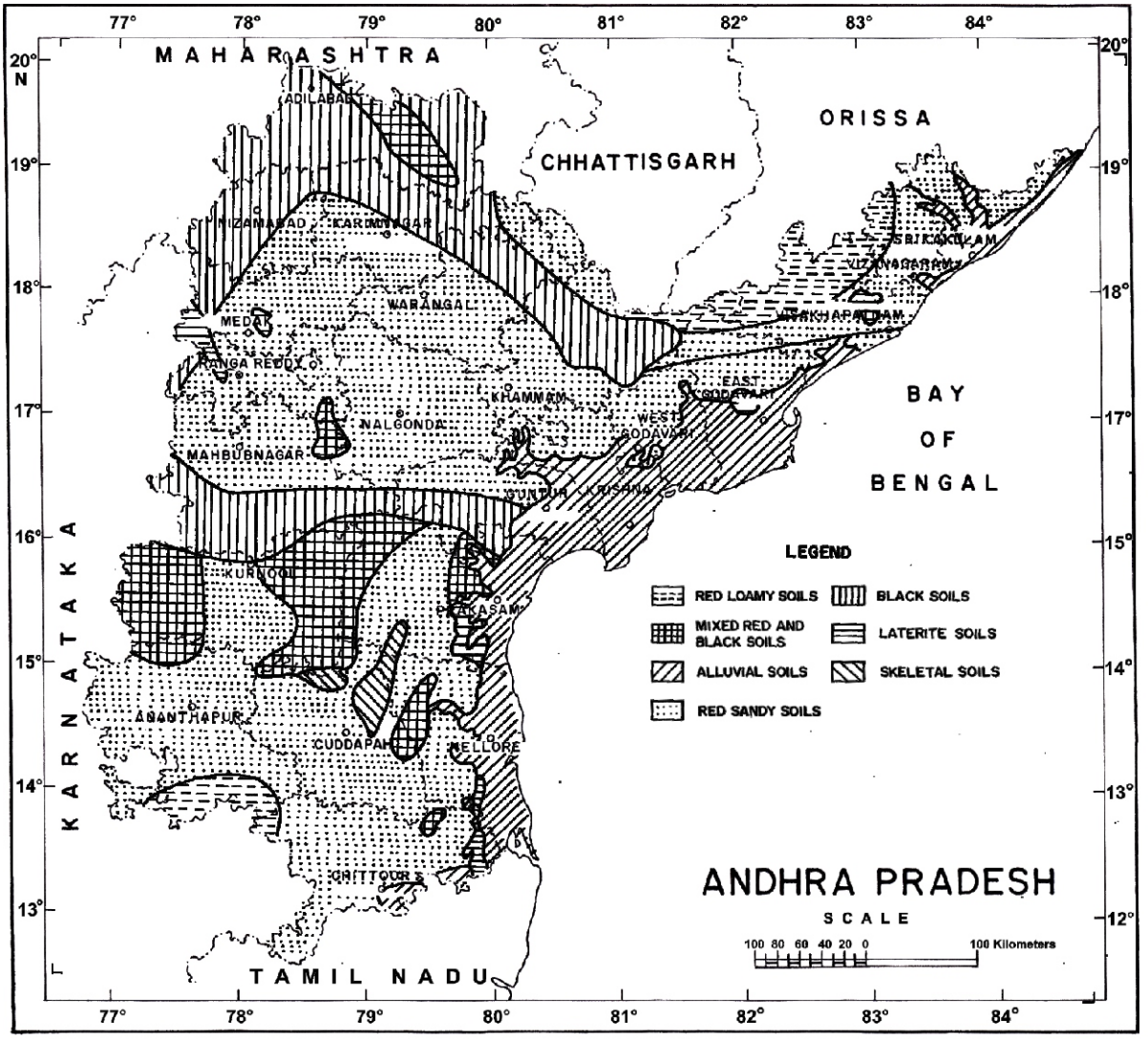


FIG. 3: SOILS OF ANDHRA PRADESH

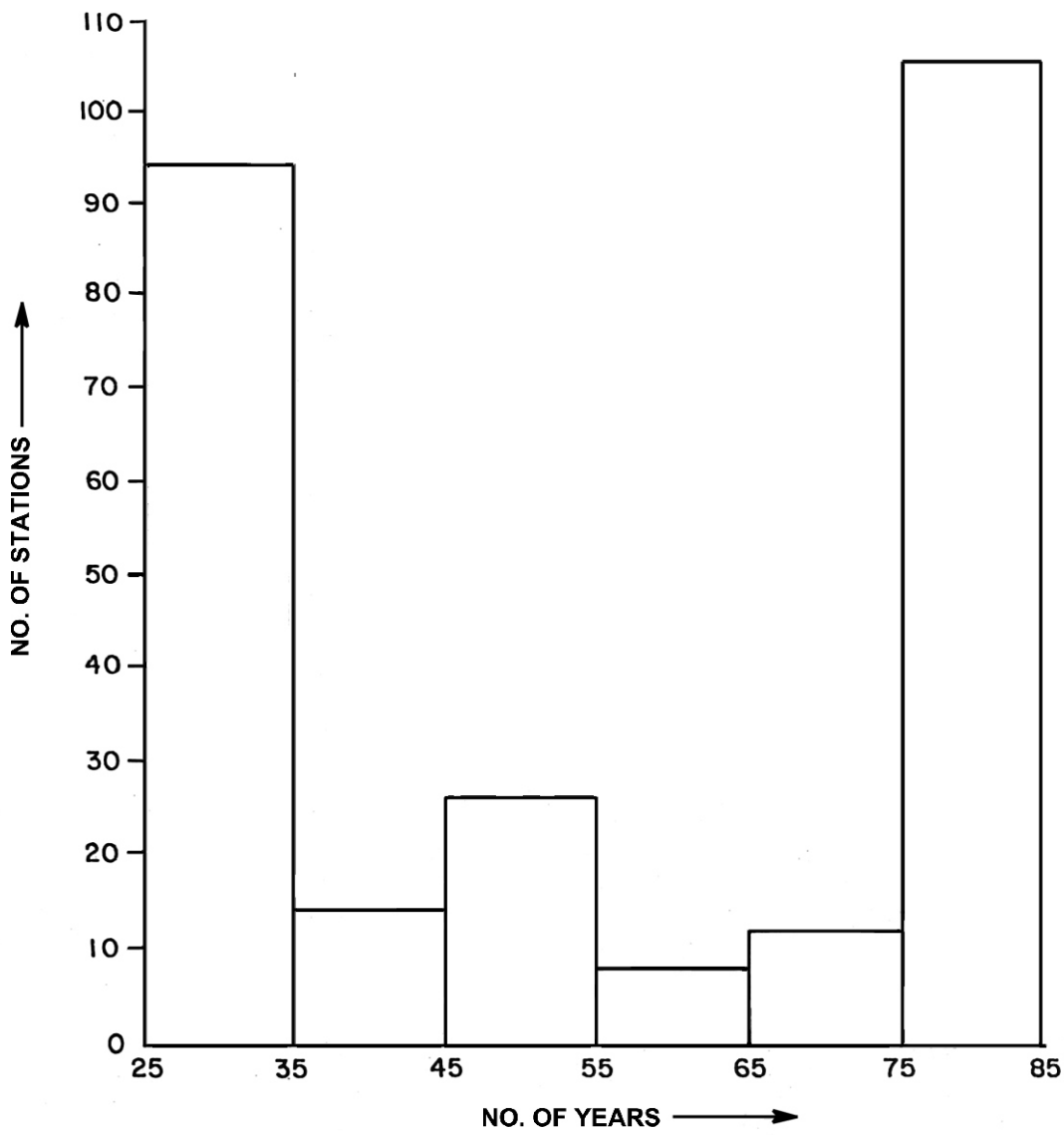


FIG. 4: AVAILABILITY OF RAINFALL DATA FOR DIFFERENT STATIONS

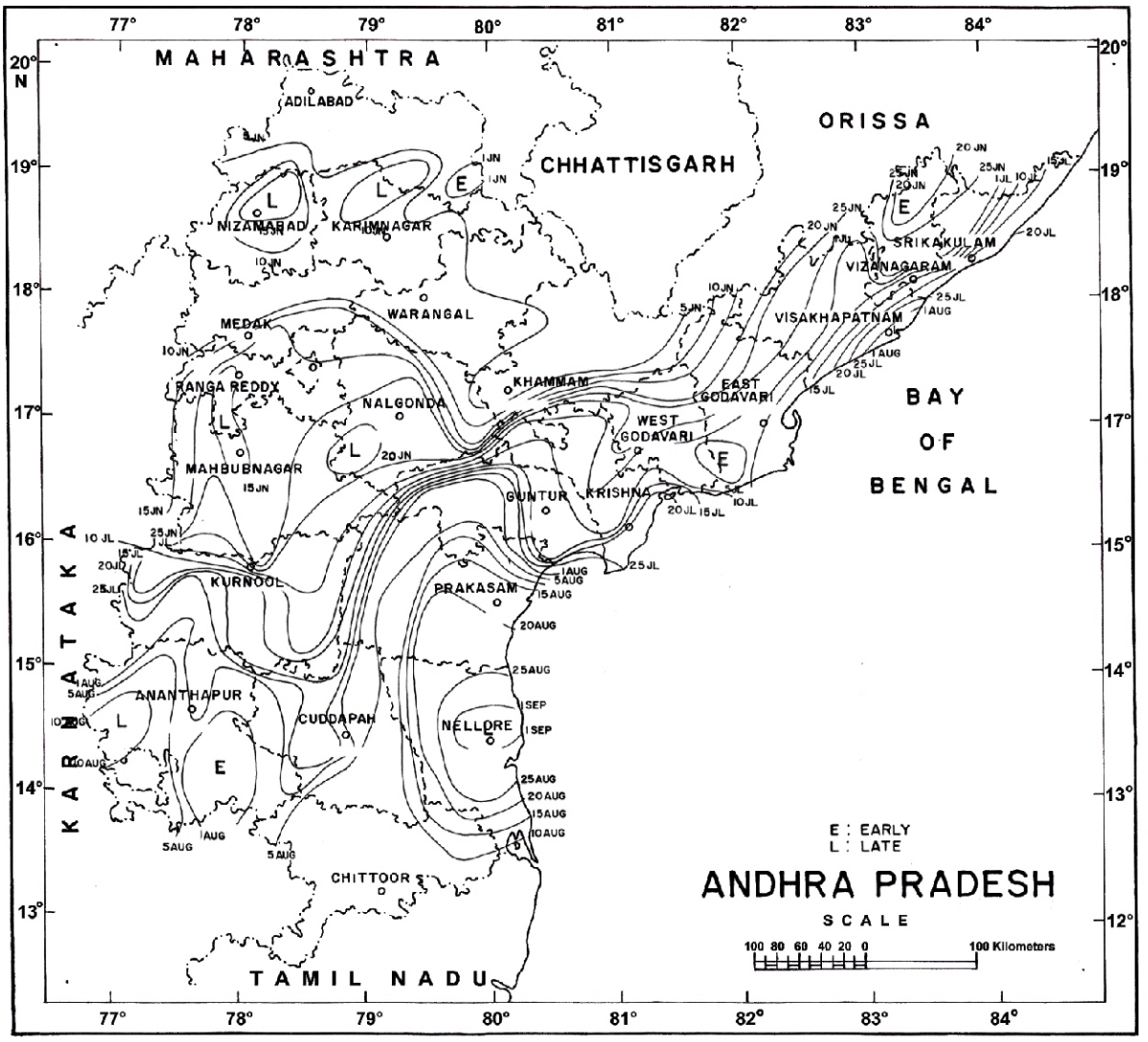


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FIG. 5: MEAN DATES OF COMMENCEMENT OF SOWING RAINS

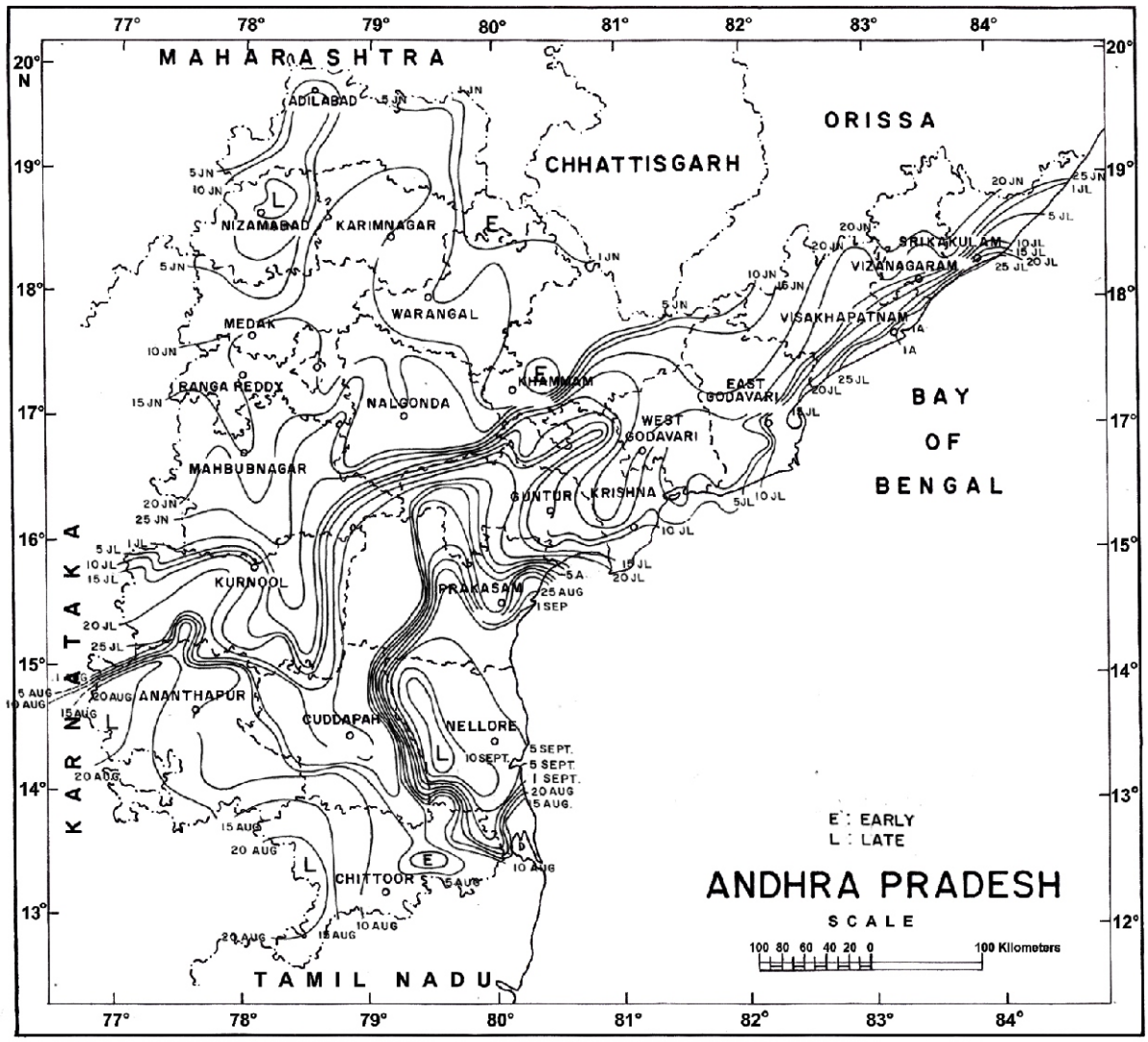

FIG. 6: MEDIAN DATES

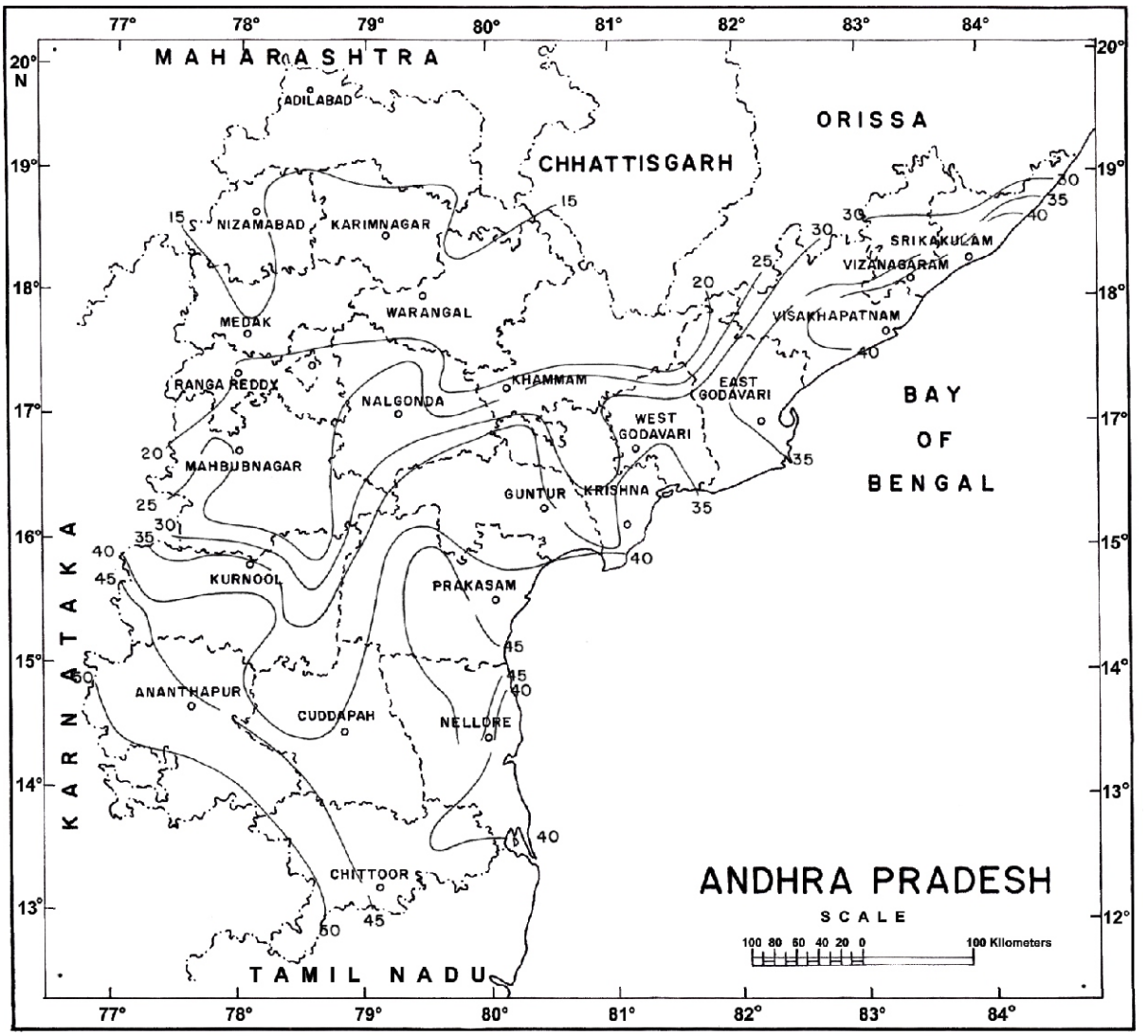

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FIG. 7: STANDARD DEVIATION (DAYS)

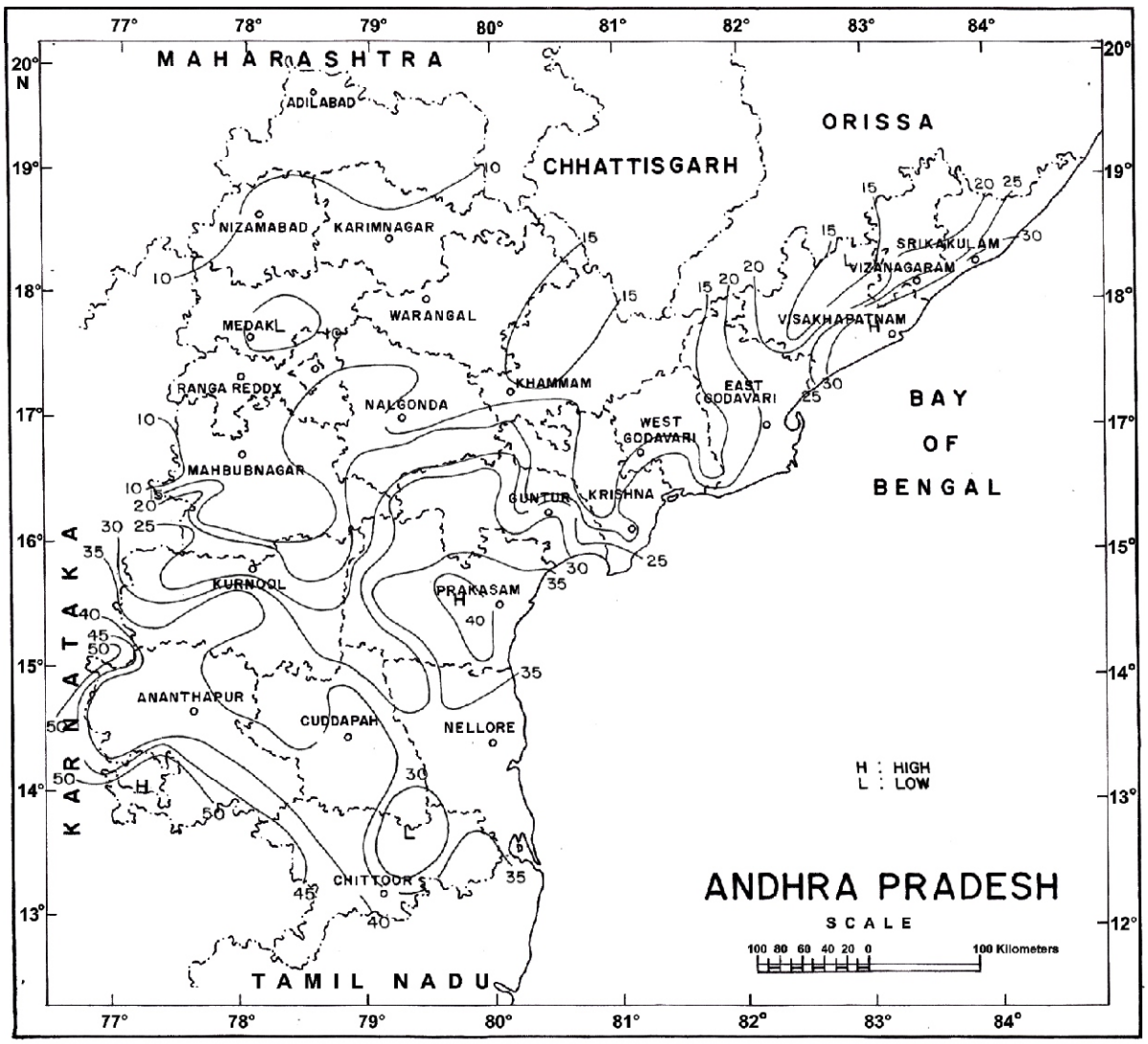

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FIG. 8: DISTRIBUTION OF SEMI - INTER QUARTILE RANGE

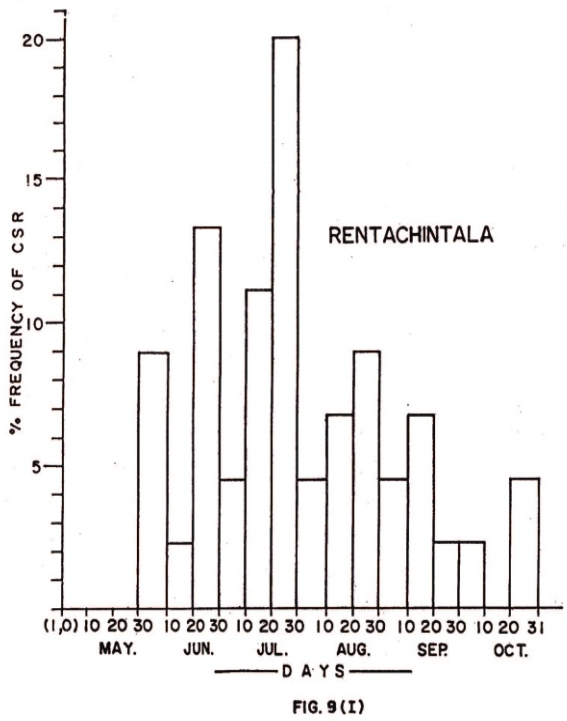

FIG. 9 (I)

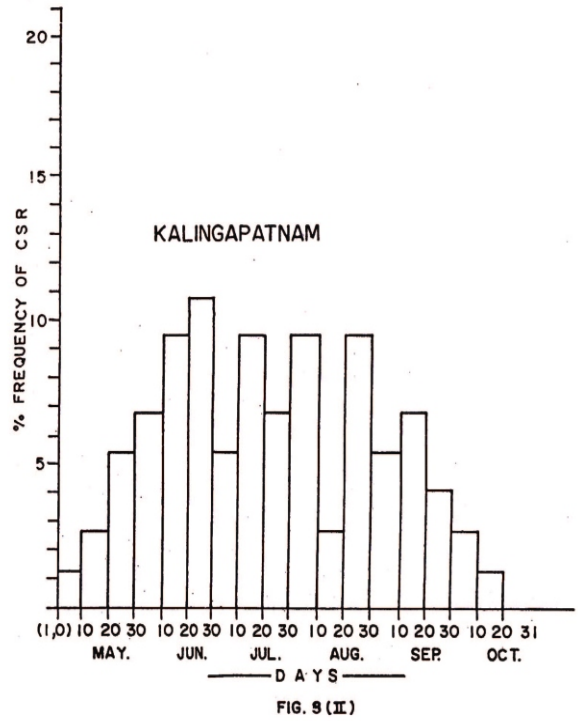

FIG. 9 (II)

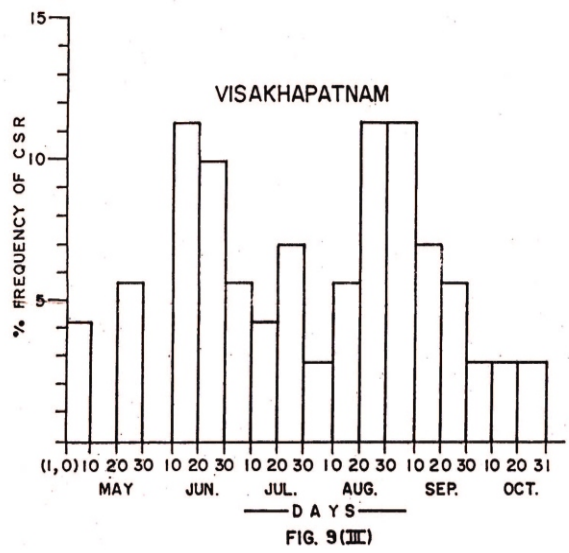

FIG. 9 (III)

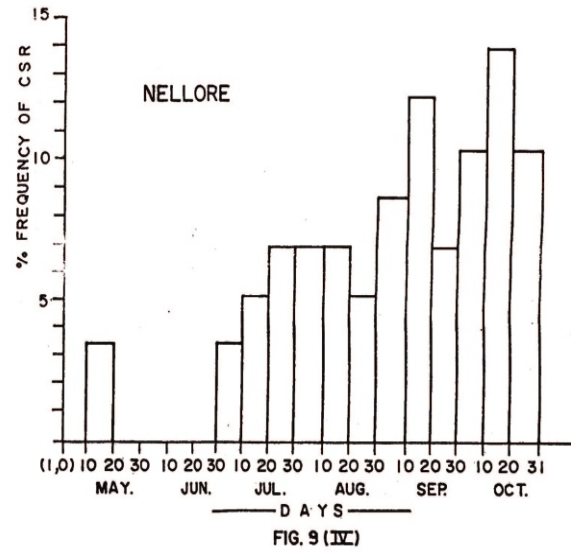

FIG. 9 (IV)

FIG. 9: FREQUENCY DISTRIBUTION OF SOWING DATES FOR SELECTED STATIONS

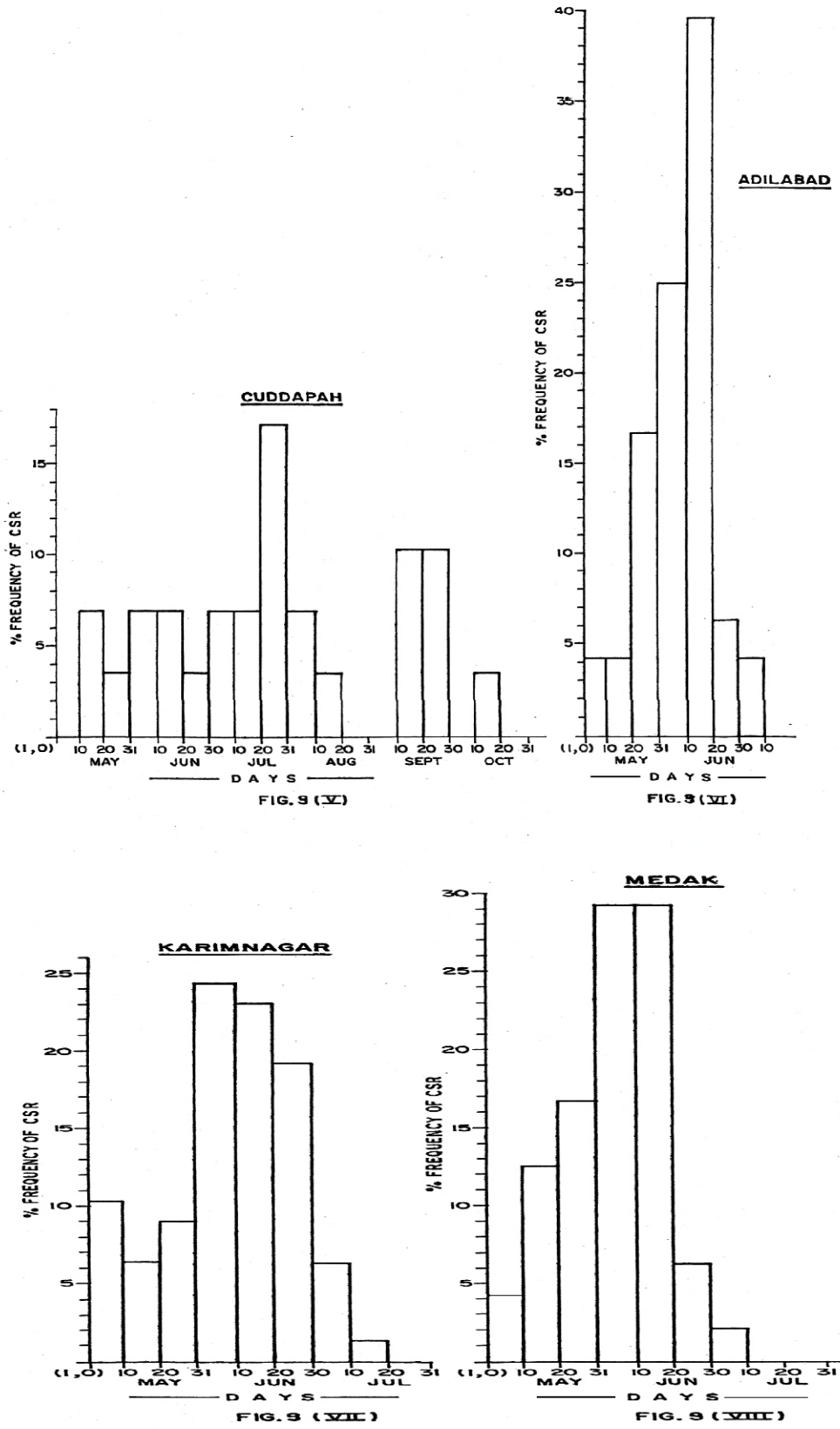

FIG. 9: FREQUENCY DISTRIBUTION OF SOWING DATES FOR SELECTED STATIONS

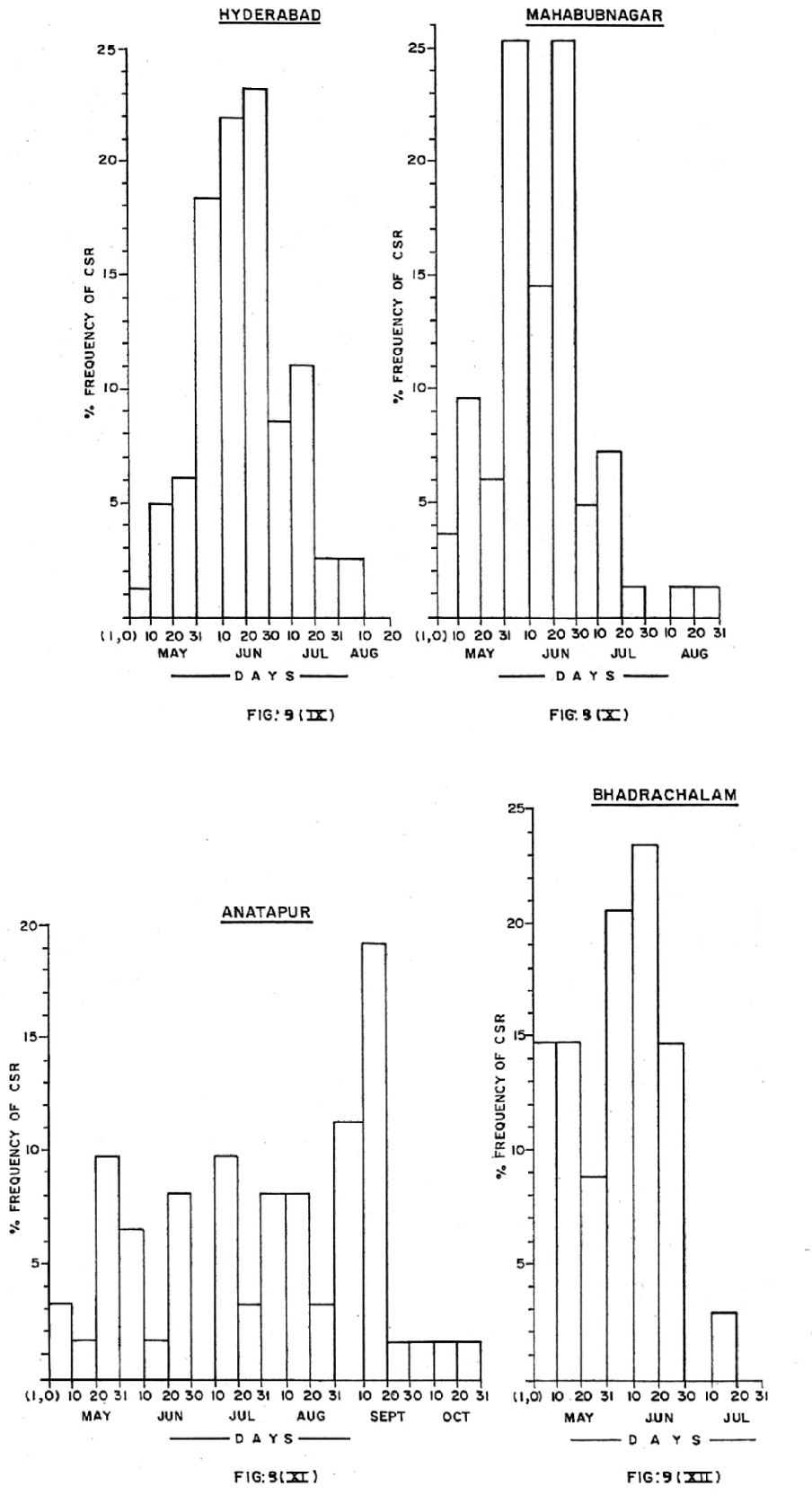

FIG. 9: FREQUENCY DISTRIBUTION OF SOWING DATES FOR SELECTED STATIONS

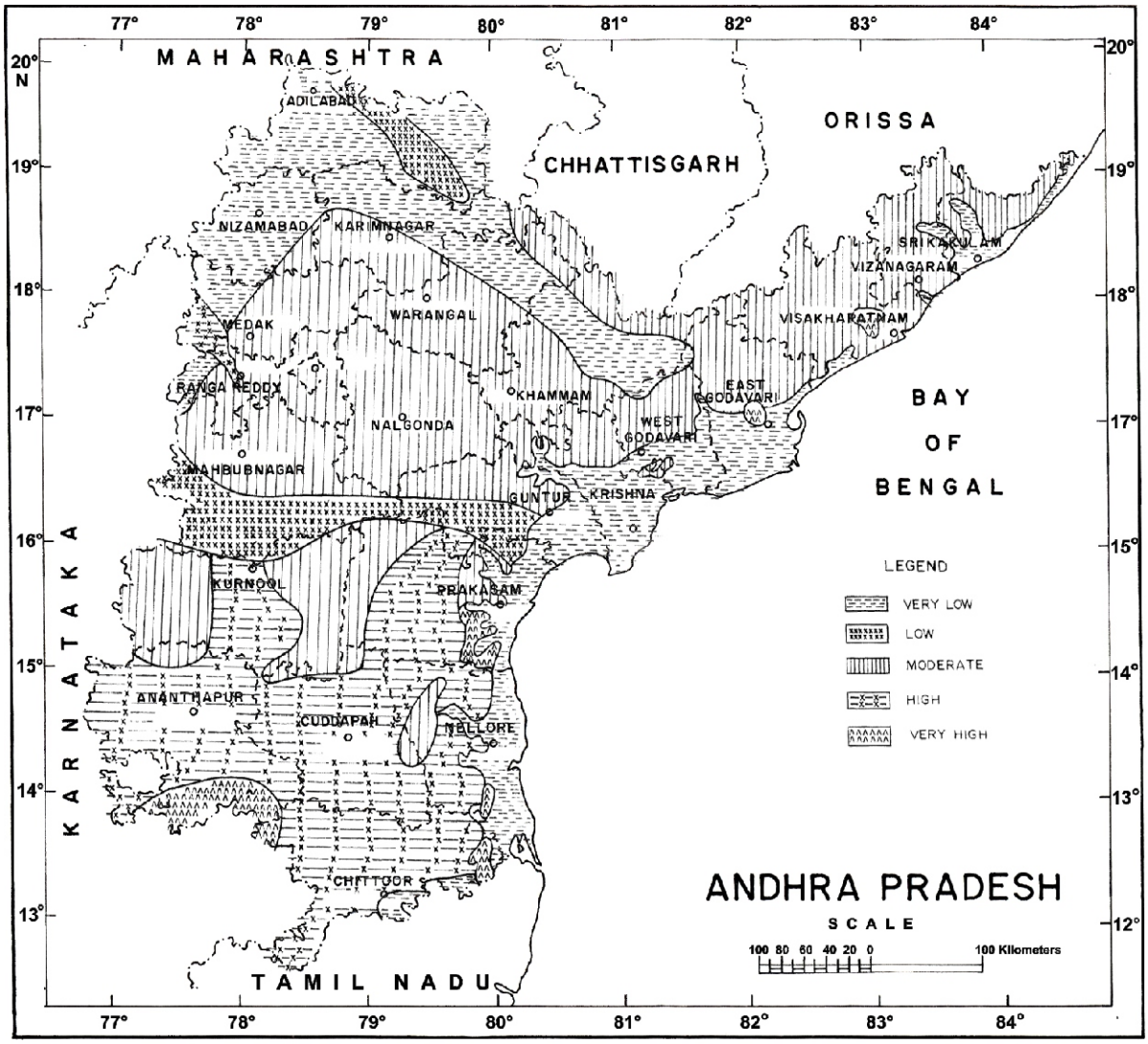

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FIG. 10: DROUGHT PRONENESS