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Weekly growing periods in extremities over India – monsoon period

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ABSTRACT
India, being an agrarian country, the studies on Growing periods plays an important role in crop growth and performance in particular during the ocean atmospheric interactions such as ENSO/ LNSO, which modulate the south west monsoon of India. The present paper addresses not only the growing period of India and selected stations from the Moist and Dry climates of India during the monsoon period of 1951-80, 1981-91, 1992-98, on a weekly basis, but also the affectivity of ocean atmospheric interactions such as ENSO/LNSO and SST of Nino 3 region for the ENSO year (1987) and LNSO year (1988) through the revised water balance model. The trend analysis of growing periods with respect to the march of SOI and SST of Nino 3 region for the period 1992-98 has been presented.

INTRODUCTION

The crop performance depends not only on precipitation but also on agro meteorological parameters such as humidity, moisture, soil moisture adequacy and the length of the growing period. The soil moisture and temperature regime play an important role in controlling the soil formation and also plant growth. The period of moisture availability in soil is given by the soil moisture regime, which is a function of soil type and depth of the roots. The moisture control section varies from 10-30 cm in fine, 20-60 cm in medium and 30-90 cm in coarse textured soils (NBSS & LUP). When the water is held between the filed capacity (at 1/3 bar) and wilting point (at 15 bar) in parts of the moisture control section, the soil is considered to be moist. The plant growth is congenial when the soil temperature is in between 5° and 35° C. It controls the biotic activity as well as the availability of moisture and nutrients to the plants. These have indirectly been used to determine the length of the growing period. The growing period is the period when the moisture in soils is adequate enough to support plant growth. The growing period starts when the precipitation exceeds 50% of the water need and ends when the assumed quantum of stored soil moisture and rainfall falls below the 50% of the demand.

Sehgal, Vernemnene & Tavernier (1987) prepared an agro- ecological region map of the country based on the hypsography, soils, bio-climate and length of the growing period.

Khambete (1992) has given an agro climatic classification for assessment of crop potential of Karnataka, using the water availability index, which is applied to dry farming tracts of Karnataka.

Das & Datar (1998) have reported the prospects of double cropping of rice in rainfed areas in West Bengal and found that harvesting two rice crops of shorter duration is feasible during the growing period covering pre monsoon and monsoon season.

Sengupta, Das & Kele (2001, 2002) studied the consumption of cotton and sunflower in the semi arid tracts of India and Deccan Plateau, using evapotranspiration and other agro meteorological indices.

Kashyaji (2002) reported the influence of meteorological parameters such temperature, rainfall, relative humidity, bright sunshine hours on the possible growing season and crop performance in rainfed cropping system in a given area.

It has been widely reported that the ocean-atmospheric interaction through SST of Nino 3 and SOI will influence the global rainfall (Ropelewski & Halpert 1996; Smith & Ropelewski 1997) and also the Indian summer monsoon circulation pattern that may cause a delay in onset, shorter duration and breaks in monsoon which lead to breaks in the

growing period.

Verma & Das (2003) studied the agro-meteorological aspects during the growth of wheat at New Delhi. Water requirement of the crop during various stages of its growth, water use efficiency, crop coefficient and available soil water depletion in the root zone in relation to growth and yield of the crop have been discussed.

Sarma & Lakshmi Kumar (2006 a), highlighted the effect of warm phase of ENSO on the agro climatic elements such as potential evapotranspiration, and soil wetness. Sivaram & Sarma (2008) have studied the affectivity of ocean atmospheric interactions on the hydro climatic elements such as humidity and moisture indices over India during the monsoon period, which are the basic parameters in plant growth and productivity.

Sarma & Lakshmi Kumar (2007) reported the increasing and decreasing trends of vegetation with LNSO and ENSO respectively. A statistical model was developed, using rainfall and mean temperature to predict the groundnut yield over Saurashtra (Dubey, Bhan & Attri 2006). Sarma, Srinivas & Karthikeya (2005) pointed out that the hydrological cycle of India is affected in accordance with LA-NINA and EL-NINO SO signals.

The study of agro climatic potentialities were carried out by many research workers using water balance model on monthly, seasonal and yearly basis and a study of these, in particular growing periods on a weekly basis is of much relevance in the agricultural operation schedule through weekly climate concept.

In the present investigation, some of the aspects of the affectivity of ocean atmospheric interactions on the growing degree, through the water balance model with reference to All India and for the selected stations from the varied climates from the climate spectrum of India on a weekly basis have been discussed. The trend analysis of the length of the growing weeks in response to the march of SOI and SST of Nino 3 has been reported.

MATERIALS AND METHODOLOGY

The revised water balance concept of Thornthwaite & Mather (1955) is followed in computing the water budget elements for 90 stations that are drawn from varied geographical settings of India based on the Normals of Agroclimatic Observaatories India (IMD) and the data supplied by the IMD, PUNE on a weekly basis for the standard monsoon period (22nd week to 39th week) (Gore & Thapliyal 1999).

The length of the weekly growing period has been calculated following the FAO model (Higgins & Kassam 1981) using weekly values of the precipitation and potential evapotranspiration. The growing period as per the model starts when the precipitation (P) exceed 50% of potential evapotranspiration (PET) and ends with the utilization of the assumed quantum of stored soil moisture after the precipitation (P) falls below potential evapotranspiration.

The variations in the length of the growing periods on a weekly basis for the southwest monsoon period are presented not only for All India, but also for the selected stations from the climate spectrum of India. The classification of the growing weeks is as follows:

If the precipitation (P) is	**Type of the growing week**
Below 0.5 *PE	Dry
In between 0.5 PE and PE	Moist
More than PE	Humid

The statistical results of the present investigation in terms of occurrence of All India dry, moist and humid growing weeks are segregated not only for the period of 1951-1980 but also for the period of 1981-1991, 1992-1998, ENSO year (1987) and LNSO year (1988) with a view to study the variations in occurrence of these extremities during the monsoon period. The trend analysis has been presented for the growing period with respect to the march of SOI and SST of Nino 3 for the period 1992-1998 to understand the affectivity of SOI and SST of Nino 3 on the length of the growing period.

RESULTS AND DISCUSSION

Growing Weeks in Extremities – All India

The country as a whole witnessed 17- humid, 1-moist growing weeks during the monsoon period of Long term (1951-1980), 1981-1991, 1992-1998 and LNSO year (1988). During the ENSO year (1987), All India has experience 11-humid, 6-moist and 1-dry growing weeks. The affectivity of the ENSO on the growing period is evident from the depreciation in humid weeks, accompanied by an increase in moist and dry growing weeks during the ENSO year (Table 1).

Table 1. Occurrence of Growing weeks – Monsoon Period – Extremities

All India

S.No.	Year	Number of Growing Weeks		
		Humid	Moist	Dry
1.	Longterm (1951-1980)	17	1	0
2.	1981-1991	17	1	0
3.	1992-1998	17	1	0
4.	1981-1998	17	1	0
5.	Enso Year (1987)	11	6	1
6.	Lnso Year (1988)	17	1	0

TABLE 1 HERE

Growing Weeks in Extremities – Moist Climates:

a) Perhumid Zone (A): Tocklai has witnessed 94 - humid, 19 - moist and 13 - dry weeks in a total of 126 weeks of study (Table 2). During the LNSO year (1988), Tocklai has registered 10 - humid, 6 - moist and 2 - dry weeks showing a decrease of 7 - humid weeks (4%), where as there was an increase in the moist weeks by 5 and dry weeks by 2, compared to normal humid (17), moist (1) weeks (Table 3). In the ENSO year (1987) this station has experienced 13 – humid, 4 – moist and 1 – dry weeks, showing a depletion of 4 (24%) humid weeks and an increase in the moist weeks by 3 (200%) and dry weeks by one from the normal respectively. It is evident that there is no continuity in the humid growing period during the monsoon periods of ENSO as well as LNSO years due to the frequent variations in the monsoon rainfall in the respective monsoon periods. On the other hand the continuity in the humid growing period is prevailed in the normal situation.

Karjat experienced 103 – humid, 6 – moist and 17 – dry weeks in a period of 126 growing weeks (Table 2). The ENSO year (1987), it has witnessed 12 – humid, 2 – moist and 4 – dry weeks, which shows a decrease in the humid weeks by 5 (29%) and an increase in the moist weeks by 1 (100%) and in the dry weeks by 4 from the respective normal (Table.3). There was a depreciation of 1 (6%) – humid and an increase of 2 – dry growing weeks in the LNSO year (1988) from the respective normal. Growing period is more consistent in all extremities, except in the warm phase of ENSO.

b) Humid Zone (B): The frequencies of occurrence of humid, moist and dry weeks are 87, 34 and 41 respectively at Bhubaneshwar, during the period of study of 162 weeks (Table.2). The ENSO year (1987) has recorded 8 – humid, 4 – moist and 6 – dry weeks which shows a decrease in humid weeks by 9 (53%) with an increase in the moist weeks by 3 (300%) and dry weeks by 6 (600%) from the respective normal (Table 3). The LNSO year (1988), witnessed 10 – humid, 3 – moist and 5 – dry growing weeks, which showed a decrease in the humid growing weeks by 7 (41%) and an increase in the moist by 2 (200%), dry weeks by 5 from the respective normal. Due to heavy fluctuations in the weekly rainfall during the monsoon periods of extremities, the humid period is inconsistent with an exception to the normal situation.

Adhartal has witnessed 89 – humid, 21 – moist and 52 – dry weeks during the 162 weeks of study (Table 2). During the ENSO year (1997), Adhartal witnessed 12 – humid and 6 – dry growing weeks indicating a reduction in the humid by 1 (7%), with a rise in the dry weeks by 3 (100%) from the normal (Table 3). Adhartal experienced 9 – humid, 3 – moist and 6 – dry growing weeks during the LNSO year (1988), that shows a depletion of 4 (31%) humid weeks with a rise in moist and dry weeks by 1 (50%) and 3 (100%) respectively from the normal. The humid growing period is prevailed for a considerable duration in extremities.

Table2. Occurrence of Growing weeks – Monsoon Period – 1981-1998

S.No.	Station	Number of Growing Weeks		
		Humid	Moist	Dry
1.	**All India**	17	1	0
	Per humid Zone (A)			
1.	Tocklai	94	19	13
2.	Kariat	103	6	17
	Humid Zone (B)			
1.	Bhubaneshwar	87	25	50
2.	Adhartal	89	21	52
	Moist subhumid Zone (C_2)			
1.	Junagarh	55	26	81
2.	Parbhani	73	19	70
	Dry subhumid Zone (C_1)			
1.	Jhansi	67	17	78
2.	Rajendhranagar	61	22	79
	Semi arid Zone (D)			
1.	Jodhpur	18	12	114
2.	Aduthurai	8	6	40

c) Moist subhumid Zone (C_2): Junagarh experienced 55 – humid, 26 – moist and 81 – dry weeks in a period of 162 weeks of study (Table 2). In the LNSO year (1988), the frequency of humid events is high (11), in which there was an increase in humid weeks by 1 (10%), dry weeks by 3 (75%) with a depreciation of 4 (100%) dry weeks from the normal (Table.3). It is observed that due to the vagaries in the rainfall distribution during the monsoon periods of the extremities, the occurrence of humid growing period is discontinuous. It is also interesting to observe that during the ENSO year (1997), due to high variability in the rainfall distribution there is an inconsistency in the humid growing period.

From a period of 144 weeks of study, Parbhani experienced 73 – humid, 19 – moist and 70 – dry weeks (Table 2). In the LNSO years 1988, the frequency of humid weeks (11) was high, but it was low (5) in the ENSO year 1987, with a depreciation in the frequency of humid, moist , accompanied by an increase in the dry weeks by 6 (55%), 3 (50%) and 9 (900%) respectively from the corresponding normal (Table 3). There was no change in the humid weeks, but a depletion of moist weeks by 3 (50%) with an increase in dry weeks by 3 (300%) is observed in the extreme wet and LNSO year (1988). From the growing period diagrams, it is evident that, due to several dry spells, ENSO and LNSO respectively, the humid growing period prevailed for shorter duration over

Table 3. Occurrence of Growing weeks in Moist Climates – Monsoon Period – Extremities during 1981-1998

S.No.	Station	Year	Number of Growing Weeks		
			Humid	Moist	Dry
	Perhumid Zone (A)				
1.	Tocklai	Longterm	17	1	0
		ENSO year (1987)	13	4	1
		LNSO year (1988)	10	6	2
2.	Karjat	Longterm	17	1	0
		ENSO year (1987)	12	2	4
		LNSO year (1988)	16	0	2
	Humid Zone (B)				
1.	Bhubaneshwar	Longterm	17	1	0
		ENSO year (1987)	8	4	6
		LNSO year (1988)	10	3	5
2.	Adhartal	Longterm	13	2	3
		LNSO year (1988)	9	3	6
	Moist subhumid Zone (C_2)				
1.	Junagarh	Longterm	10	4	4
		ENSO year (1997)	7	4	7
		LNSO year (1988)	11	0	7
2.	Parbhani	Longterm	11	6	1
		ENSO year (1987)	5	3	10
		LNSO year (1988)	11	3	4

Parbhani.

Growing Weeks in Extremities – Dry Climates:

Dry subhumid Zone (C_1): Jhansi registered 67 – humid, 17 – moist and 78 – dry weeks in a period of 162 weeks study (Table 2). In the ENSO year (1987), a rise of humid weeks by 4 (40%), moist weeks by one (50%) and dry weeks by 3 (50%) from the normal are noted (Table 4). During the LNSO year (1988), the frequency of humid, moist and dry growing weeks is 6, 2 and 10, that showed a decrease in the humid weeks by 4 (40%) and an increase in dry weeks by 4 (67%), from the respective normal. In the, ENSO and LNSO years there is a sequence of dry, moist and humid growing periods through out the monsoon period.

Rajendranagar experienced 87 – humid, 34 – moist and 41 – dry weeks in a period of 162 weeks of study (Table 2). In the ENSO year (1987), this station recorded a decrease in humid weeks by 1 (14%), moist weeks by 7 (78%) and an increase in the dry weeks by 8 (400%), while in the LNSO year (1988), there was an increase in humid weeks by 3 (43%), moist week by 7 (78%) and dry weeks by 4 (200%) from the normal respectively (Table 4). Very short-term humid growing periods prevailed in all the

Table 4. Occurrence of Growing weeks in Dry Climates – Monsoon Period – Extremities during 1981-1998

S.No.	Station	Year	Number of Growing Weeks		
			Humid	Moist	Dry
	Dry subhumid Zone (C_1)				
1.	Jhansi	Longterm	10	2	6
		ENSO year (1987)	6	3	9
		LNSO year (1988)	6	2	10
2.	Rajendranagar	Longterm	7	9	2
		ENSO year (1987)	6	2	10
		LNSO year (1988)	10	2	6
	Semi Arid Zone (D)				
1.	Jodhpur	Longterm	2	8	8
		ENSO year (1987)	0	1	17
2.	Aduthurai	Longterm	0	9	9

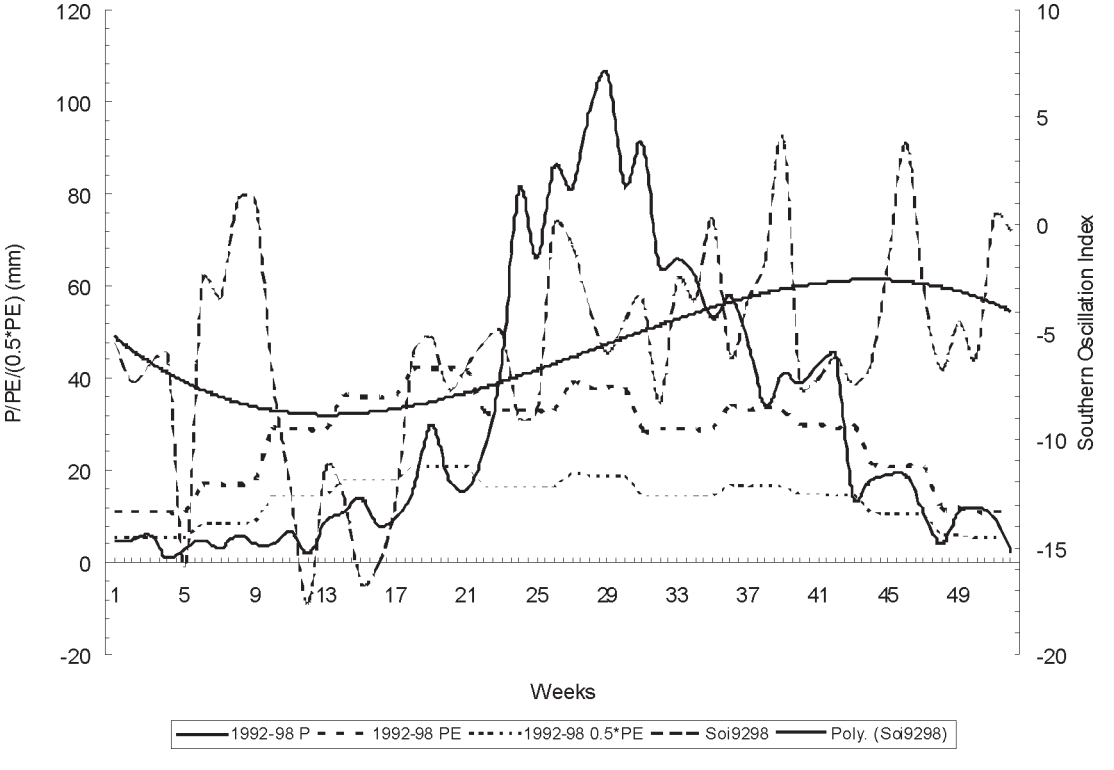

Figure 1a. March of All India Growing weeks and SOI for the period 1992-1998.

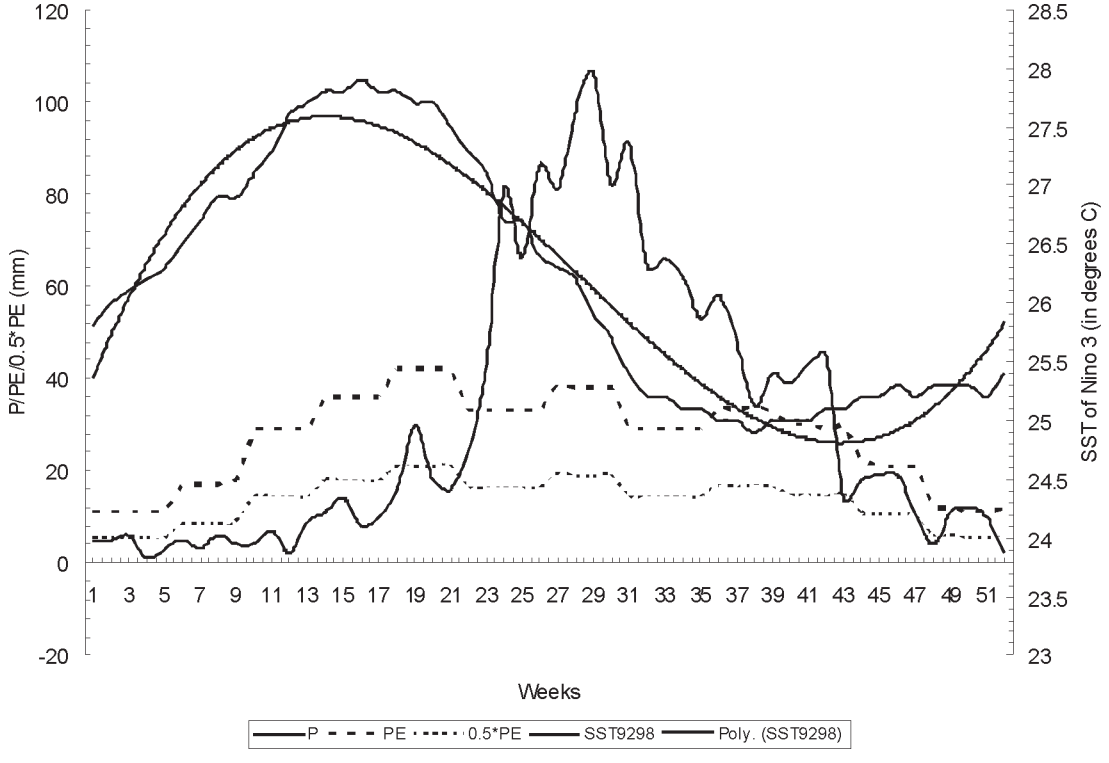

Figure 1b. March of All India Growing weeks and SST of Nino 3 for the period 1992-1998

extremities, which are due to sub normal rainfall distributions.

From the above analysis it is inferred that the selected stations from the dry subhumid zone are highly prone to dry period. In the ENSO years, the selected stations from this zone have recorded a rise in dry weeks with a reduction in the moist and humid period from the respective normal, except at Jhansi.

Semi Arid Zone (D): Jodhpur registered 18 – humid, 12 – moist and 114 – dry weeks in a period of 144 – weeks of study (Table 2). The ENSO year (1987), recorded a maximum 17 dry weeks and there was a steep rise of 9 (113%) dry weeks and a drastic fall of moist weeks by 7 (88%), with a fall of humid weeks by 2 (100%) from the respective normalcy. The LNSO year (1988) has experienced 2 – humid, 4 – moist and 12 – dry growing weeks, there by indicating an increase in the moist weeks and dry weeks by 4 each (Table.4). No humid weeks was recorded in the ENSO year 1987. It is evident that, the dry growing period is consistent, due to the subnormal rainfall distribution in the extremities.

Aduthurai registered 8 – humid, 6 – moist and 40 – dry weeks during the period of study (Table 2).

Trend Analysis of Growing periods of All India with SOI and SST of Nino 3:

The length of the humid growing period of All India has increased with increasing SOI accompanied by a decreasing SST of Nino 3 and decreasing with falling SOI in conjunction with rising SST of Nino 3. As a result, length of Moist and Dry growing periods has reduced, both in pre and post monsoon periods (Fig.1 a & b)

SUMMARY AND CONCLUSIONS

The affect of ENSO has reduced the number of humid growing weeks over the country as whole. There is variation in the number of growing weeks in the remaining periods of study over India.

It can be concluded that the frequency of humid growing weeks is high at all the selected stations from the perhumid zone of India.

The selected stations from the humid zone of India are highly prone to humid weeks during the period of study. The stations showed depreciation in humid weeks and a rise in the moist and dry weeks during the extremities, from the respective normal with an exception to Adhartal.

It is observed that Junagarh is highly prone to dry

weeks, while Parbhani frequently witnessed humid weeks. In the extremities, the stations that are representing moist subhumid zone have recorded a decrease in the frequency of humid weeks with an increase in the moist and dry weeks, with an exception to Junagarh, during LNSO year (1988), compared to normal.

An increase in the duration of dry period with compression in the moist and humid period is observed at all the stations of dry subhumid zone during the LNSO years. Two stations representing the semi arid zone are highly prone to dry period, during the study period. A rise in the dry period is noticed with a fall in the humid and moist period during the monsoon period of extreme situations situations, from the respective normal. The length of the Humid Growing period has increased with a reduction in the duration of Moist and Dry growing period due to falling SOI accompanied with a rising SST of Nino 3 over All India.

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REFERENCES

Das, H.P.& Datar, S.V., 1998. Prospects of double cropping of rainfed rice in West Bengal, Mausam, 49, 1, 121-126.

Dubey, D.P. Bhan, S.C. & Attri, S.D., 2006. A statistical model for predicting ground nut yield over Saurashtra, Vayumandal, 32 (1-2), 33-36.

Gore, P.G. & Thapliyal, V., 1999: Occurrence of Dry and Wet weeks over Maharashtra, Mausam, 51, 1.

Higgins, G.M.& Kassam, A.H., 1981: The FAO agro-ecological zone approach to determination of land potential, Pedologie, XXXI, 2:147-168.

Kambete, N.N., 1992: Agroclimatic Classification for assessment of the crop potential of Karnataka, Mausam, 43, 1, 91-98.

Kashyaji, A. 2002: Influence of Meteorological parameters on performance of rainfed Cropping Systems, Mausam, 53, 1.

Ropelewski, C.F. & Halpert, M., 1996. Quantifying southern oscillation – precipitation relation ships. J.Climate, 9, 1043-1059.

Sarma, A.A.L.N., Srinivas, S. & Karthikeya, A., 2005. Studies on aberrations in climate impacts – Water balance model. Ind.Geophys.Union, 9, 3, 209-219.

Sarma, A.A.L.N., Srinivas, S. & Karthikeya, A., 2005. Studies on aberrations in climate impacts – Water balance model. Ind.Geophys.Union, 9, 3, 209-219.

Sarma, A.A.L.N & Lakshmi, T.V., 2006a. Studies on agroclimatic elements and soil wetness estimation from MSMR data, J. of Agrometeorology, 8(1), 19-27.

Sarma, A.A.L.N.& Lakshmi Kumar, T.V., 2007. An approach in understanding Drought condition using NDVI, A.P. Academy of Sciences, 11(1), 74-80.

Sehgal, J.L.,Vernemnene, C. & Tavernier, R., 1987. Agroclimatic Environments and moisture regimes in NW India – Their Applications in Soils and Crop Growth, Research Bull, NBSS Publ., 17, Nagpur, India, NBSSLUP, pp.117.

Sengupta, S., Das, H.P. & Kale, A.A., 2001. Water Consumption of Cotton in the semi-arid tracts of India, Mausam, 53, 1.

Sengupta, S., Das, H.P. & A.A.Kale, 2002: Water use pattern and related Agroclimato-logical indices of Rabi and Kharif sunflower at Deccan Plateau, Mausam, 53, 4.

Sivaram, B & Sarma, A.A.L.N., 2008. Studies on hydrologic extremities over India - Monsoon Period, J.Ind. Geophys. Union, 12, 2, 79-88.

Smith, T.M. & Ropelewski, C.F., 1997. Quantifying Southern Osicalltion – precipitation relationships from an atmospheric GCM. J.Climate, 10, 2277-2284.

Verma, I.J. & Das, H.P., 2003. A Study on available Soil Water during the growth of Wheat at New Delhi, Mausam, 55, 3.

Thornthwaite, C. W. & Mather, J. R., 1955 a: The Water Balance.Publ.in Clim, Drexel Instt.Tech, 8, No.1.

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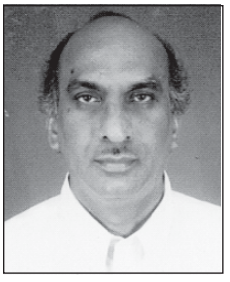

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