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Research Article

INFLUENCE OF ENSO ON LENGTH OF GROWING PERIOD OVER TAMIL NADU

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Abstract: Variability is a very important intrinsic characteristic of climate and it varies on all timescales, it can also be described as a combination of some preferred spatial patterns. Climate variability affects weather and climate on many spatial and temporal scales. The seasonal cycle is the most significant periodic climate variability mode. The opposite is true during La Niña. Daily rainfall data at district scale obtained from India Meteorological Department (IMD) for a period of 43 years (1971-2013) was categorized based on the ENSO episodes for assessing the impact of ENSO on seasonal rainfall variability and length of growing period (LGP) for rainfed cropping period (RCP, September-December). LGP was calculated in each district by estimating number of days between onset and cessation in addition to support from soil moisture for crop growth from the last spell of rainfall. The results revealed that the El Nino condition positively influenced the rainfed cropping period rainfall and vice-versa during La Niña years. Tamil Nadu experiences the LGP between 91 and 126 days (13-18weeks). The LGP was higher under El Nino followed by neutral and La Niña conditions.

Keywords: *ENSO, Onset, Cessation, Soil moisture, LGP*

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Introduction

El Nino Southern Oscillation (ENSO) is the dominant mode of climate variability on seasonal to inter-annual scales and its impacts are felt worldwide [1]. ENSO often affects seasonal temperature, precipitation and thus crop yields in many regions, however, the overall impacts of ENSO on global yields are uncertain [2]. The ENSO phenomenon is a coupled ocean atmosphere interaction driven by the anomalously warm (El Nino phase) or cold (La Nina phase) sea surface temperatures (SST) in the Eastern Equatorial Pacific [3]. ENSO is often thought as an irregular inter-annual oscillator that swings between warm and cold sea surface temperature and low and high surface pressure over the central and eastern tropical Pacific. The warm ("El Nino") and the cold ("La Nina") phases, occurs alternatively. These changes include the modification of the Sea Surface Temperature (SST) for large areas of the Pacific Ocean. The changes in SST also modify the climate in a vast area of the planet [4,5]. The El Nino phase is marked by a deep layer of warm ocean water across the east-central equatorial Pacific, with sea surface temperatures generally 1.5°-2.5°C above average. La Nina related conditions are opposed to those of El Nino: a deep layer of cooler than average ocean temperatures across the east-central equatorial Pacific, with sea-surface temperatures generally 1.0°-2.0°C below average [6]. It has been widely reported that the ocean atmospheric interaction through SST of Nino 3 and Southern oscillation index (SOI) will influence the global rainfall [7,8] 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. The difference in mean onset of rainfall dates in El Nino years compared with the overall mean (1950-2008) onset of rainfall shows a high variation over the Free State Province of South Africa. Some areas experienced earlier than normal onset (anomalies less than 4 days), other places showed delayed onset of rains El Nino years (anomalies of greater than 5 days) while sizeable number of others exhibit near normal dates (anomalies between 4 and 5 days). Notable areas where onset dates were earlier than normal and there were also sporadic cases of earlier onsets around in some areas. Early onsets can elongate the growing period and thus benefit the maize crop provided the rainy season ends at normal or later than normal dates. Later than normal onset dates were mostly in the vicinities of Frankfort, Reitz and Sasolburg over the northern and northeastern parts of Free State Province. The late onset of rains can result in a short growing season in the event of early or normal end to the rainy season [9]. In La Nina years, the onset of rain does not follow any discernible pattern just like the results obtained for El Nino years during which some places have earlier than normal onsets while others experience near normal to later than normal onsets [9].

Materials and Methods

Description of the study area

Tamil Nadu is located in the Southernmost tip of the Indian Peninsula between 8°5' and 13°35' North latitude and 76°15' and 80°20' East longitude with 960 km coastline. Tamil Nadu is characterized by a tropical climate, and receives rainfall during both the South West Monsoon season (SWM, June-September), North East Monsoon (NEM, October-December) and Rainfed cropping period (RCP, September-December) season for rainfed crops.

ENSO linked climate variability

The National Oceanic and Atmospheric Administration (NOAA) define El Nino and La Nina events based on a threshold of +/- 0.5°C for the Oceanic Nino Index (ONI) (3 months running mean of SST anomalies over equatorial eastern Pacific) (http://ggweather.com/enso/oni.htm). ENSO years segregated into two groups as El Nino and La Nina and remaining years were classified under neutral category

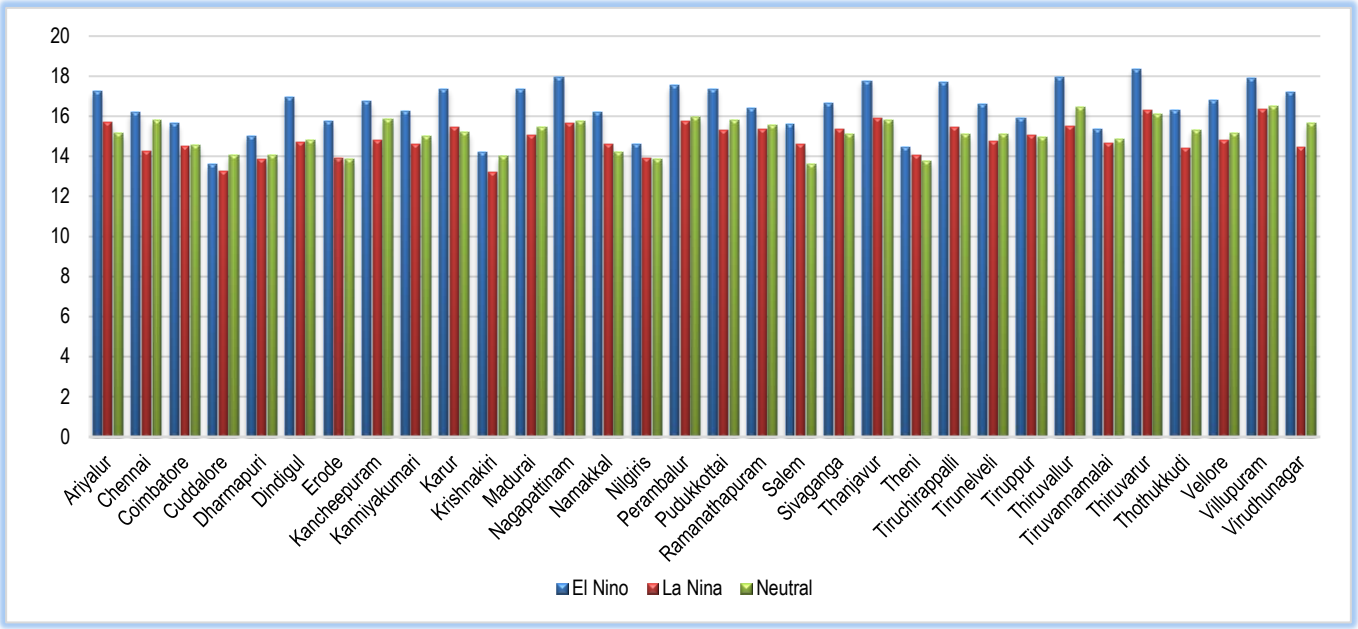

Fig-1 ENSO Effect on Length of Growing Period (LGP) in different districts of Tamil Nadu

[Table-1] to perform the analysis separately and compare the result under different situations through variability analysis.

Table-1 *El Nino, La Nina and neutral years from 1971 to 2013*

El Nino	La Nina	Neutral
1972, 1976, 1977, 1979	1971, 1973, 1974, 1975	1978, 1980, 1981, 1985
1982, 1986, 1987, 1991	1983, 1984, 1988,1995	1989, 1990, 1992, 1993
1994,1997, 2002, 2004	1998, 1999, 2000,2007	1996, 2001, 2003, 2005
2006, 2009	2010, 2011	2008, 2012, 2013

Influence of ENSO on length of growing period (LGP)

LGP was calculated in each district by estimating number of days between onset and cessation in addition to support from soil moisture for crop growth from the last spell of rainfall

Onset and Cessation of monsoon

Onset of rainfed cropping period was determined using the pentad analysis performed from 1st Sep. to 10th Oct. Considering first pentad with quantum of 10 mm of rainfall and four consecutive pentads records 10 mm of rainfall per pentad. Cessation of monsoon was seen in December month. In case of cessation didn't occur during December, the cessation time was noted in November month. In the end of the season the last day received the rainfall amount of > 2.5 mm considered to be an indicator of cessation of monsoon [10].

Available soil moisture supports to the crop after cessation

Available soil moisture (ASM) was calculated by cumulating rainfall of continuous wet spell just before cessation and deducting the assumed water loss due to evapo-transpiration which is depending upon the soil type from the cumulated rainfall. In calculating the cumulative rainfall, if the rainfall is more than the water holding capacity of the soil, then the cumulative rainfall was limited to the soil water holding capacity. The number of days the cumulated rainfall supported for water loss was added to the LGP to calculate the growing season.

Results and Discussion

Quantum of rainfall received was more during El Nino years followed by normal years over Tamil Nadu. In contrast, La Nina years registered lesser than average rainfall.

Effects of ENSO Onset and Cessation of RCP

The results of the RCP onset of rains showed clear pattern over Tamil Nadu. Most of the area in Tamil Nadu exhibited the start of sowing rain period during 1st week of September (1st to 7th September) for El Nino (67.9 %) and Neutral (65 %) Phases [Fig-1] whereas results signify that 51.1 % of the La Nina years had sowing rain in the 1st week of September and 39.1 % years exhibited one week delay in the start of sowing rain (*i.e.*, 2nd week of September). La Nina years showed early cessation compared to El Nino and neutral years. Most of the years under El Nino event had cessation during last week of December whereas most of the La Nina years had cessation before last week of December which was early by 7 days than El Nino. ENSO impacted the onset and cessation of rainy season [9].

Table-2 *Effect of ENSO on Length growing period during Rainfed cropping Period*

District	LGP (weeks)		
	El Nino	La Nina	Neutral
Ariyalur	17*	16	15
Chennai	16	14	16
Coimbatore	16	15	15
Cuddalore	14	13	14
Dharmapuri	15	14	14
Dindigul	17	15	15
Erode	16	14	14
Kancheepuram	17	15	16
Kanniyakumari	16	15	15
Karur	17	15	15
Krishnakiri	14	13	14
Madurai	17	15	15
Nagapattinam	18	16	16
Namakkal	16*	15	14
Nilgiris	15	14	14
Perambalur	18	16	16
Pudukkottai	17	15	16
Ramanathapuram	16	15	16
Salem	16	15	14
Sivaganga	17	15	15
Thanjavur	18	16	16
Theni	14	14	14
Tiruchirappalli	18*	15	15
Tirunelveli	17	15	15
Tiruppur	16	15	15
Thiruvallur	18	15	16
Tiruvannamalai	15	15	15
Thiruvarur	18	16	16
Thothukkudi	16	14	15
Vellore	17	15	15
Villupuram	18	16	16
Virudhunagar	17	14	16
Maximum	18	16	16
Minimum	14	13	14
Average	16	15	15

*- Significant differences considered when $p \leq 0.05$ (Student's t -test)

Effects of ENSO on the length of growing period

The effect of ENSO on LGP presented in [Table-2] and [Fig-1]. Tamil Nadu experiences the LGP between 91 and 126 days (13-18 weeks). The mean analysis indicated that during El Nino years the LGP was higher (ranged from 14 to 18 weeks) compared to La Nina (13 to 16 weeks) and neutral (14 to 16 weeks) phases. However, Student's t -test showed statistical significance only in few districts (Ariyalur, Namakkal and Trichy)

Conclusion

The Length of Growing Period (LGP) was higher under El Nino years followed by neutral and then La Nina conditions. Delay in the start of sowing rain and early cessation with the La Nina phase resulted in shortened length of growing period compared to El Nino and neutral phases.

Application of research: The seasonal Length of Growing Period is influenced by variability of rainfall due to ENSO.

Research Category: Climate variability

Abbreviations:

ENSO: El Nino southern oscillation
SOI: Southern oscillation index
LGP: Length of growing period
ASM: Available soil moisture
NOAA: National Oceanic and Atmospheric Administration
ONI: Oceanic Niño Index

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Cultivar / Variety / Breed name: Nil

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