



Research Article

ANNUAL AND SEASONAL RAINFALL PROBABILITY ANALYSIS OF GUNTUR DISTRICT OF COASTAL ANDHRA PRADESH, INDIA

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Abstract: Historical district average seasonal and annual rainfall was analysed to know the seasonal and annual rainfall distribution pattern and found that out of the 883.0 mm of normal annual rainfall, 65% of the rainfall received during the SWM, 26.3% of rainfall received during the NE monsoon period and the remaining during summer and winter periods. Decade wise annual rainfalls were analyzed and found that 29 years out of 62 years under study has recorded below normal rainfall. Monsoon period wise rainfall was analyzed and the results indicated that SW monsoon period was normal in 32 years, experienced drought in 13 years and surplus in 17 years. NE monsoon was found to be normal in 28 years, drought occurred in 24 years and surplus in 10 years. Seasonal rainfall statistics indicated that the rainfall variation was more during the winter (85.0%), summer (71.0%), NE monsoon (61.3%) and it was comparatively low during SWM (29.0%) and the probability analysis of the monsoon rainfall indicated that low during SW monsoon (29.0%). The probability analysis of winter season being dry is 56.0% in the Guntur district of south Coastal Andhra Pradesh.

Keywords: Season, Decade, South west monsoon, North east monsoon, Probability, Rainfall

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Introduction

Rainfall is one of the climatological parameter which is widely analyzed on long term basis for particular location or region. Analysis of rainfall data is important as it facilitates policy decisions regarding the cropping pattern, sowing date, construction of roads, buildings and providing drinking water to urban and rural population in addition to the irrigation to crops. Guntur district of the South Coastal Andhra Pradesh is located at 16° 30' N latitude and 80° 43' longitude and elevated at 39.7m MSL, as like Indian agriculture the district agriculture is also monsoon dependent. Rainfall received during the monsoon period is a governing factor to determine crops, cropping pattern, individual crop area and production & productivity of various crops in addition to source of filling of all minor, major reservoirs and water bodies in the district. The evaluation of past trends of meteorological parameters particularly on rainfall data at various spatial and temporal scales plays a crucial role in understanding climate change and its impact on food security, energy security, natural resource management and sustainable development; The present study focused on the analysis of rainfall data in Guntur district, a south coastal city of the state of Andhra Pradesh, hence an effort to analyze the rainfall data of Guntur district from 1958-59 to 2019-20.

Material and Methods

The study area Guntur is located in the south coastal part of the Andhra Pradesh at 16° 30'67" N, 80° 43'65" E and stands 25 km near to the river Krishna. The rainfall data (1958-59 to 2019-2020) was collected from statistical Officer from the office of the Joint Director of agriculture and Chief Planning Officer, Guntur district of Andhra Pradesh. A detailed knowledge of the rainfall regime at a place is an important prerequisite for agricultural planning, execution and its proper management. Rainfall is the important agro-meteorological variable influencing crop production and productivity. In the absence of reliable physically based seasonal forecasts, crop management decisions and planning have to rely on statistical assessment based on the analysis of historical rainfall records.

Hence, the historical rainfall data of Guntur district located at 16° 31' N latitude, 80° 41' E longitude and -33m+ from MSL in the south coastal Andhra Pradesh for the period from 1958 to 2020 was examined to know the decade wise rainfall pattern by adopting certain standard statistical and numerical methodologies as described below.

Depending upon the monsoon the district rainfall was classified as South West monsoon, North East monsoon, winter and summer period and summarized the seasonal rainfall as total annual rainfall.

Normal Annual/Seasonal rainfall

Statistical parameters of rainfall

Mean (Average of rainfall) (\bar{X})

Standard deviation (SD)

Co-efficient of variation (Cv %)

Mean rainfall

Mean rainfall of the study area was estimated by using sample mean and that is the average and is computed as the sum of all the observed outcomes from the sample divided by the total number of events as the symbol for the sample mean used was $\bar{X} = \sum X/n$

Where n are the sample size and the x corresponding to the observed values.

Standard deviation of the sample

An estimator for sigma sometimes used is the standard deviation of the sample, denoted by SD and defined as follows. Standard deviation (SD), where (X_1, X_2, \dots, X_n) are the observed values of the sample items and \bar{X} is the mean value of these observations, while the denominator N stands for the size of the sample.

Co-efficient of variation (Cv%)

Co-efficient of variation is the percentage variation between mean, standard deviation being considered as the total variation from the mean. High Cv indicates that the group is more variable and less stable.

Co-efficient of variation (%) = [Mean] / [Standard Deviation] x 100

In other words, co-efficient of variation (Cv) is defined as ratio of the standard deviation to the mean.

Percentage deviation of rainfall from normal

The percentage deviation formula is very useful to determining accurate values in the rain fall data.

Percentage deviation (%) = [Annual rainfall - Average annual rainfall] / [Average annual rainfall] x 100

Rainfall categorization

Following the standard definitions, the years and seasons were classified as surplus, normal and drought. The following definitions, suggested by Sharma *et al.* (1979) have been used in the analysis:

Normal month/Season

Any month receiving precipitation between 50 and 200 per cent of the monthly/seasonal rainfall.

Surplus month/Season

Any month receiving precipitation greater than 200 per cent of the monthly/Seasonal.

Drought month/Season

Any month receiving precipitation less than 50 per cent of the monthly/Seasonal.

Normal year: Any year receiving rainfall between y1 and y2. *i.e.*, $y1 < Y < y2$

Surplus year: Any year receiving rainfall greater than or equal to y2. *i.e.*, $Y > y2$

Drought year: Any year receiving rainfall less than or equal to y1. *i.e.*, $Y < y1$

where, Y = annual rainfall (mm);

$y1 = X - S$; $y2 = X + S$;

X= Mean annual rainfall (mm); and

S = Standard deviation (mm).

Results and Discussion

Normal annual precipitation

Past thirty years rainfall data of the Guntur district was analyzed and the results inferred that mean annual rainfall of Guntur district was 883.0 mm out of which 90 percentage of rainfall accumulates in the monsoon season right from June to December in that also nearly 65% rainfall (558.3 mm) was arrived during the major cropping period (south west monsoon season) and 26.3 % (226.7 mm) arrived during north east monsoon period [Fig-1].

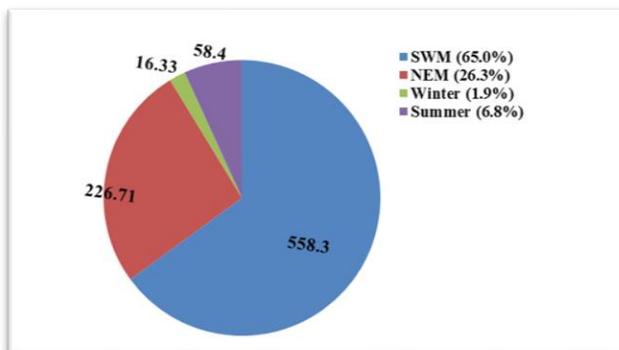


Fig-1 Season wise normal rainfall distribution pattern of Guntur District.

Rainfall categorization

Annual rainfall analysis

Decadal mean annual rainfall of Guntur district was figure out to know the annual rainfall deviation pattern from normal in the district and the results inferred that in

the first decade of the study *i.e.*, from 1958-59 to 1968-69, three years (1960 to 1963) reported excess rainfall of +57%, +41.0% and +98.1% respectively and on other hand two years 1965-66 (-47%) 1967-68 (-31.0%) of deficit rainfall. In the second decade rainfall of the study four continuous years are reported negative normal rainfalls in that also 1971-1972 and 1972-1973 are recorded deficit rainfall of -21.0% and -27.0%, and the year 1976-77 reported excess rainfall of +29.0%. The third decadal rainfall tendency started with the excess rainfall status of +49.0% in the year 1978-1979 and next four consecutive years are reported negative normal of -29.0%, -7.0%, -11.0% and -7.0 % deviations from the year 1979-80 to 1982-83, the rainfall status of the fourth decade under the study revealed that four years reported excess annual rainfall of +22.0% in 1988-1989, +69.0% in 1989-1990, +25.0% in 1991-1992 and +21.0% in 1996-1997 where as in the same decade none of the years reported deficit rainfall, the decade from year 1998-1999 to 2007-2008 alternate years reported positive normal and negative normal rainfalls, in that also the years 1998-99 (+24.0%) , 2003-2004 (+25.0%) and 2007-2008 (+30.0%) reported excess rainfall and the year 2002-2003 reported (-39.0%) of deficit rainfall, where as in the last decade of the study the year 2010-2011 and 2013-2014 reported excess rainfall status of +60.0 and +26.0% and the year 2011-2012 and 2014-2015 reported deficit rainfall of -24.0% and -42.0% , and the last three years under the reports were continuously recording deficit rainfalls of -23.0, -40.0 and -17.0 respectively [Fig-2].

Seasonal rainfall analysis

South West monsoon

South west monsoon is the grand rainfall period in Guntur district which falls in the Kharif season, and it's the determining factor for the cropping area in the district. the past 62 years rainfall pattern of the Guntur district was analyzed and the results revealed that out of 32 years reported normal rainfall, 13 years are with deficit rainfall, and 17 years reported excess rainfall [Fig-3].

North East monsoon

North East Monsoon period rainfall were commencing during the rabi season in the Guntur district and they play a crucial role in the yield of rabi rainfed crop yields, past six decade north east monsoon rainfall impacts those 34 years rainfalls were departed from their corresponding normal, *i.e.*, 10 years reported Excess rainfall and 24 years reported deficit rainfall, and remaining 28 years reported normal rainfall [Fig-4].

Winter

The results of the winter months rainfalls analysis revealed that 1.6% of the annual rainfall receives during the months, out of six decades of the winter rainfalls 13 years reported excess rainfall, 23 years reported Deficit rainfall, 8 years reported normal rainfalls on other hand 29% (18) of the years under study are falls under no rainfall category [Fig-5].

Summer

Summer rainfall or pre monsoon showers are the precursors for preparatory cultivation & start of the Kharif season in the district, and about 7.5% of the annual rainfall reports during the season and the summer rainfall analysis results indicated that 42 years reported the deficit rainfalls, 8 years of the study reported excess rainfall and 12 years were with normal rainfall [Fig-6].

Rainfall statistics

The statistical study of the past 62 years rainfall of the Guntur district revealed that standard deviation of the SWM rainfall has lower Cv(%) compared with other seasons that indicates decrease in the coefficient of variation resulted in the increase in the wetness of the season. The co-efficient of variation (CV) vales were in the decreasing tendency in south west monsoon, north east monsoon, winter and summer months respectively [Table-1].

Rainfall probability analysis

Probability analysis of seasonal rainfall for the past 62 years was studied and the results are depicted in the [Table-2] indicated that 98.3 percent probability is there

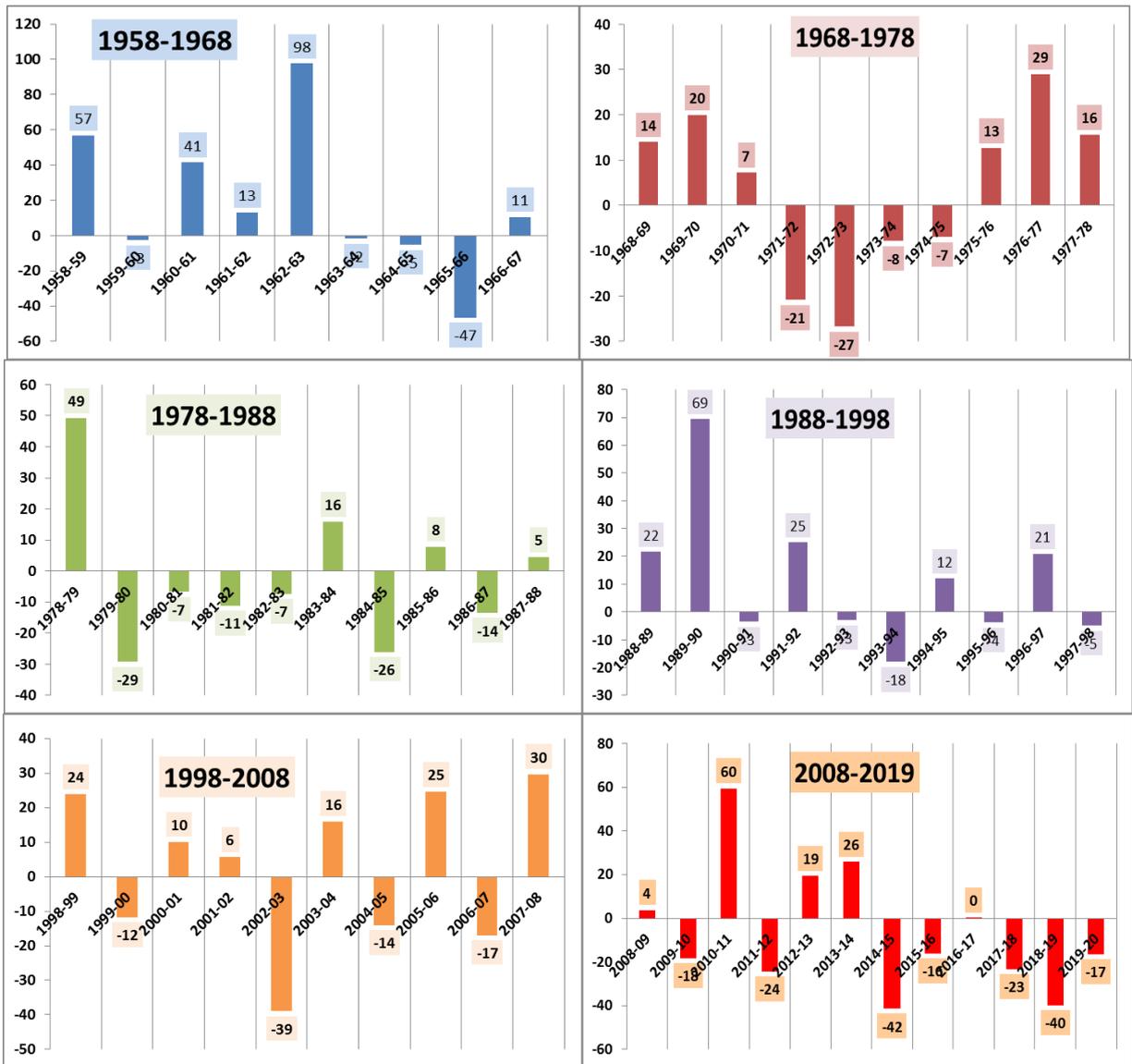


Fig-2 Annual rainfall deviation pattern of Guntur District (1958 to 2019)

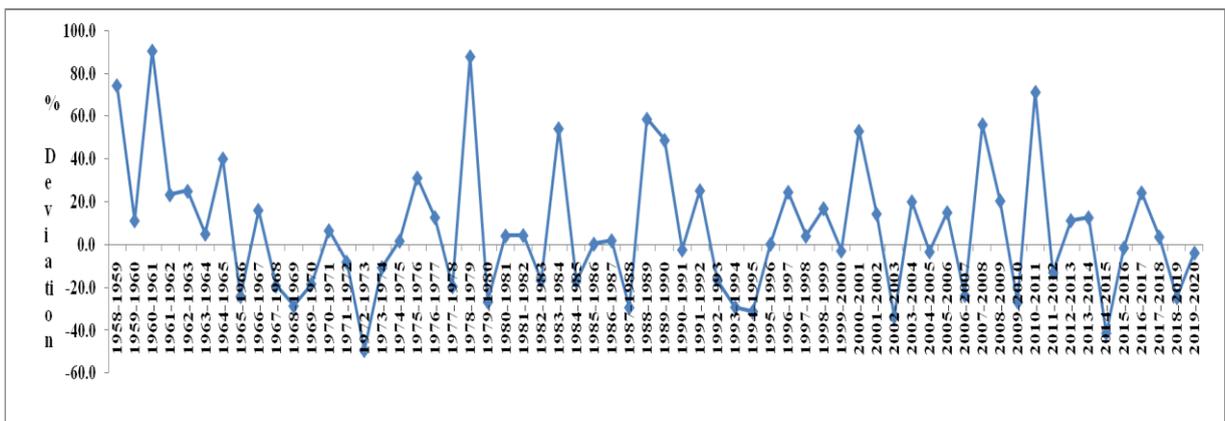


Fig-3 South West Monsoon rainfall deviation pattern of Guntur District (1958 to 2019)

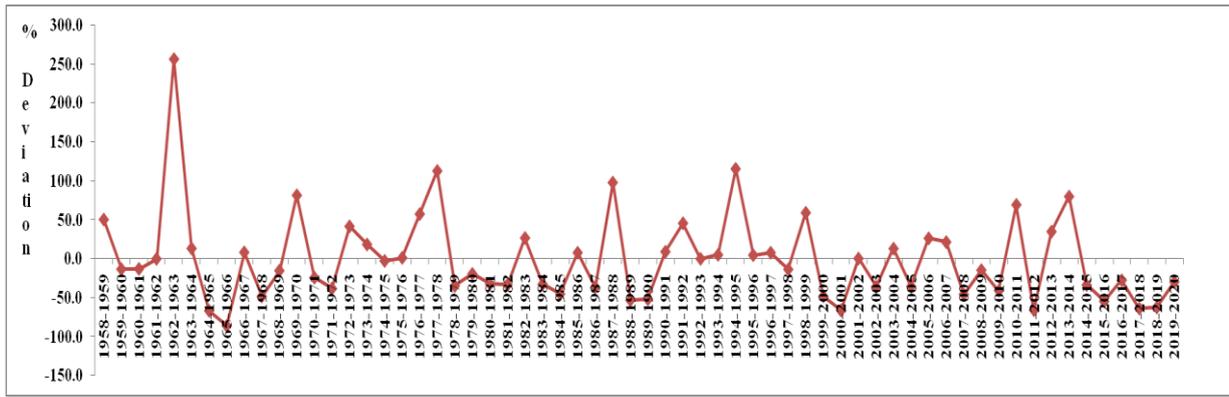


Fig-4 North East Monsoon rainfall deviation pattern of Guntur District (1958 to 2019)

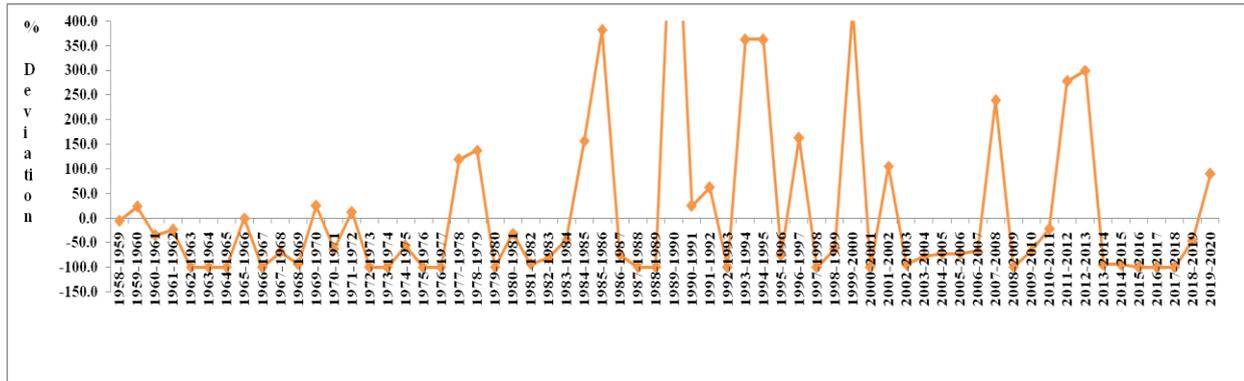


Fig-5 Winter rainfall deviation pattern of Guntur District (1958 to 2019)

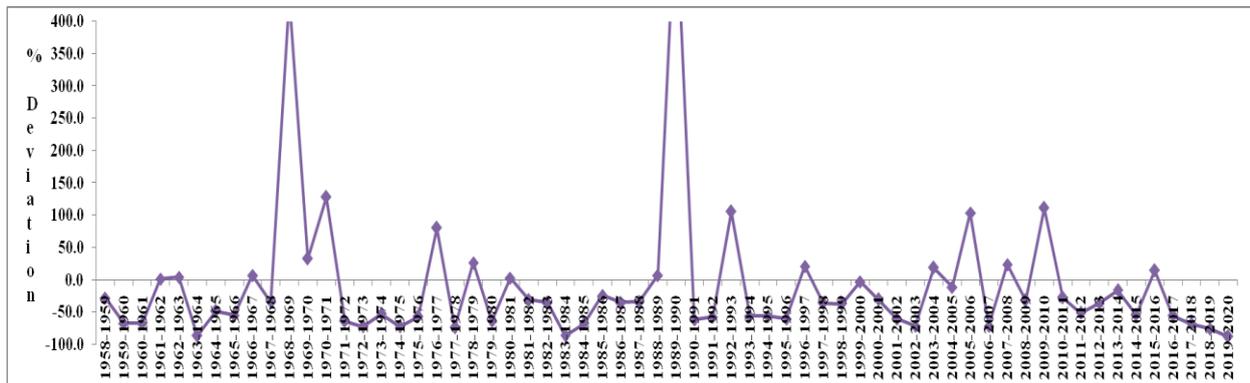


Fig-6 Summer rainfall deviation pattern of Guntur District (1958 to 2019)

Table-1 Six decade (year) seasonal rainfall statistics of Guntur district

Season	South west Monsoon period	North East monsoon Period	Summer	Winter
Mean	550.0	242.7	14.7	66.3
SD	161.5	148.8	20.55	77.28
CV (%)	29	61.3	71.0	85.00

Table-2 Probability analysis for Seasonal rainfall (mm) of Guntur district

Season	N	N/2	2N	WS Wet season	PWS Partially Wet season	NS Normal Season	PNS Partially Normal Season	DS Drought Season	PDS Partially drought season
SWM	550.0	275.0	1100.0	0.0	0.0	61.0	98.3	1.0	1.6
NEM	242.7	121.3	485.0	3.0	4.0	52.0	83.8	7.0	11.2
Winter	14.7	7.38	29.4	13.0	20.9	15.0	24.1	35.0	56.0
Summer	66.3	33.1	132.9	7.0	11.2	33.0	53.2	22.0	35.0

*N= Normal, WS=Wet season, PWS=Partially Wet season NS=Normal Season, PNS=Partially Normal Season, DS= Drought Season and PDS=Partially drought season

for getting 550.0 mm rainfall during SW Monsoon season, and 83.8 percent probability for getting 242.7 mm during NE Monsoon 56 percent probability to get below 7.38 mm rainfall in winter season and 53.2 percentage probability for being summer as normal season. These results are in conformation with the findings of Mohd Asim and Satyendra Nath (2015) and Laxman *et al* (2017) also analyzed the probability of rainfall of Ananthapuram of Andhra Pradesh.

Conclusion

This study can be concluded that the data of sixty years (1958-59-2019-20) is optimum to obtain annual maximum rainfall (mm) distribution of Guntur district of Coastal Andhra Pradesh. The most suitable probability distribution function to represent the observed data may depend on rainfall pattern of the place and it varies from place to place.

Further It can be concluded that the location based annual and season rainfall analysis can give clear cut idea on the selection of different crops and cropping pattern suitable to the location and also rainfall impact on production and productivity of crops grown in that location. And also give an idea not only on the deviation of rainfall but also on the deviation of cropped area against normal sown area under different crops in that location. It can also give an area in preparation of local agro advisories. Further more people can understand the decadal variation in the pattern of the rainfall distribution in the Guntur district of South Coastal Andhra Pradesh.

Application of research: This kind of study can be used in the preparation and dissemination of location based agro advisories as well as decision making in taking up the sowing of different crops on the amount rainfall

Research Category: Agro meteorology

Abbreviations: SWM= South West Monsoon, NEM= North East Monsoon, N= Normal, WS=Wet season, PWS=Partially Wet season NS=Normal Season, PNS=Partially Normal Season, DS= Drought Season and PDS=Partially drought season SD=Standard deviation, CV=coefficient of variation

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Study area / Sample Collection: Guntur District of Coastal Andhra Pradesh

Cultivar / Variety / Breed name: Nil

Conflict of Interest: None declared

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.
Ethical Committee Approval Number: Nil

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