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Research Article

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Chilli production and productivity in relation to Seasonal weather conditions in Guntur District of Andhra Pradesh

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ABSTRACT

Chilli is the major commercial crop of Andhra Pradesh and Guntur district ranks first in area, production and productivity in the state. The present study was conducted for assessing the influence of weather parameters, viz., temperature (minimum and maximum), sun shine hours, annual and seasonal rainfall behavior on the chilli production and productivity in Guntur district. Correlation of weather parameters with production and productivity was done based on rainfall pattern (i.e. the years where annual rainfall is <750mm, 750 to 1000 mm and >1000mm). The study revealed that the rainfall had significant positive correlation with production and productivity when rainfall was <750mm.Temperature had significant positive correlation while other weather parameters had negative correlation when rainfall was 750-1000 mm. When rainfall had >1000mm, temperature had significant positive correlation, where as rainfall in winter season had significant negative correlation. The study indicated the impact of weather conditions on production and productivity of chilli in Guntur district of Andhra Pradesh and may help in developing forecasting models based on climatic conditions.

Keywords*: Climate, Chilli, weather parameters, rainfall, temperature.*

INTRODUCTION

Crop productivity is subjected to number of stresses and potential yields are seldom achieved. The present challenges like climate change resulting in global warming, water and soil pollution, less water availability, urbanization etc adds up to the situation. Climate is the primary determinant of crop productivity. Climate change is expected to influence crop, hydrologic balances, input supplies and other components of agricultural systems. For example, crop yields are directly affected by changes in climatic factors such as temperature, precipitation and the frequency and severity of extreme events like drought, floods, and wind storms[15]. Climate models indicate that warming over will take place in the next several decades irrespective of any action taken today. Therefore, the development of varieties that can withstand abiotic stress will be the single most important step we have to take to adapt to the changes we face today and in the future.

India is the largest producer, consumer and exporter of chilli and contributes 25% of total world production. Andhra Pradesh ranks first in area, production and productivity of chilli contributing 30% of the total area and 51% of total production. Chilli is the most important commercial crop grown in vertisols of Guntur district. The crop is sensitive to weather, soil moisture as well as management practices. Uncertainties in rainfall and other environmental hazards like temperature and sunshine hours cause large year-to-year fluctuations in production and productivity. Guntur is the biggest Chilli market in Asia contributing 30-50% of the total production of Andhra Pradesh. Area and Production of Chilli in this area decides the crop prices. The fluctuations in chilli production are due to biotic and abiotic stresses. According to an estimate, crop yields less than 25 percent of the potential yield are due to the adverse environmental conditions and low water availability as much as all the other environmental factors combined.[2,3]. Stresses can occur at any stage of plant growth and development. Amongst the abiotic stresses, weather factors, excess/deficiency of soil moisture constitutes a primary limitation to crop productivity in many regions of the world[16, 17].

Chilli is sensitive to excess moisture and heavy rains during crop period may damage the crop.

Data on influence of weather parameters on production and productivity of chilli a major commercial crop of the tract is not available. Hence the objective here is to know the seasonal behavior of weather parameters on chilli production and productivity in Guntur district of Andhra Pradesh so as to know the impact of weather on yield of chilli and to develop weather forecast modules and also to take up precautionary measures in advance against pest and diseases.

MATERIALS AND METHODS

Guntur district is along the east coast of the Bay of Bengal with coastline of approximately 100 kilometers. The Guntur district is located between Latitudes 15^{o} 44' and 16^{o}47' North and Longitudes 79^{o}10' and 80^{o}55' East consisting of 57 mandals. The climate is sub-tropical with annual normal rainfall of 952.4 mm. The annual rainfall (650 mm to 950 mm) gradually increases from western part to the eastern part of the district and towards the seacoast. The soils in general are very fertile and they are broadly classified as Black cotton (70%), Red loamy (24%) and sandy loamy (6%). The monthly rainfall data of 13 years (1999-2012) was taken from AMFU, RARS, Lam to assess the seasonal rainfall and rainfall behavior. The weather data during this period was categorized into three groups based on annual rainfall (the years where the annual rainfall is <750mm, 750-1000mm, >1000mm). The weather variables, maximum and minimum temperature, annual rainfall, seasonal rainfall and sun shine hours for past 13 years (1999-2012) were correlated with production and productivity of chilli in the Guntur district of Andhra Pradesh.

RESULTS AND DISCUSSION

Seasonal rainfall

The weather data (Table-1) during 1999-2012 and descriptive statistics (Table-2) during the period under study revealed that the mean annual rainfall is 952.38 mm where the seasonal distribution of rainfall is 651.1 mm through south west monsoon (68 %), North East monsoon contributes 183.25 mm (19. %), 36.1 mm in winter (4%) and 81.93 mm during summer (9 %). There was excess rainfall in five years, normal rainfall in four years and deficit rainfall in four years. The minimum and maximum temperatures ranged from 31.8 to 35.6 ^{o}C and 21.8 to 23.3 ^{o}C respectively (table 2). Sun shine hours ranged from 5.8 to 7.4hours.

Influence of weather parameters on chilli production and productivity

The data pertaining to correlation of weather parameters during the years when the annual rainfall was less than 750mm was given in Table 3. The study indicated that significant positive correlation (Table3) was observed when annual rainfall was less than 750mm. With regard to correlation with seasonal distribution of rainfall, significant positive correlation was observed with rainfall received during south west monsoon and summer season. The positive correlation of production and productivity when rainfall is <750mm may be due to even distribution of rainfall during the period and positive correlation of rainfall during south west monsoon coincided with vegetative growth resulting in proper growth of the chilli. Negative correlation was observed with rainfall during north east monsoon season. (flowering period) resulting in poor fruit set per- centage and incidence of sucking pest complex. The distribution of rainfall during this period indicated (Fig.1) that the rainfall distribution was even in all the seasons (25-40 days in south west monsoon, 7-20days during north east monsoon, (0-7days in summer), with less or no rainfall in winter season resulting in proper growth, fruit set and pod development. In chilli several studies indicated the importance of optimum time of sowing [7,8,9,10,13], which facilitates the better crop growth with more branches in the vegetative phase duly capturing the benefits of south west monsoon and ultimately resulting in high yield. The vigorous vegetative growth in early stages also helps the plants to withstand the sucking pests and there by escaping from the incidence of viral diseases. Several studies also observed lower incidence of leaf curl virus when chilli was planted early in the season. [1,11,12].

Temperature (maximum and minimum) and sun shine hours showed significant negative correlation with production and productivity during this period i.e. when rainfall was <750 mm. Crop growth is indirectly controlled by temperature due to the balance between photosynthesis and respiration rates[18]. It may be due to lower night temperature ensures greater branching and more flowering while on the other hand, warmer night temperatures slows down the process[6].

The data pertaining to correlation of weather parameters during the years when the annual rainfall was 750 mm to 1000 mm (table3) has reverse trend to rainfall of <750mm. The temperature (maximum and minimum) has significant positive correlation with production and productivity. Similar results of increase in production were observed at higher temperatures[14]. Rainfall and sunshine hours had significant negative correlation with production and productivity. With regard to rainfall pattern, rainfall in all the seasons had negative correlation except in winter where the rainfall during this period had coincided with fruit size and development. The distribution of rainfall during this period (Fig. 2) indicated that the rainfall received during south west monsoon (>75% of rainfall in 35-45 days) was more compared to other seasons (<7days.) resulting in excess moisture only in vegetative phase with limited moisture during flowering and pod development stages. Chilli is sensitive to excess moisture. The rainfall during south west monsoon coinciding with vegetative stage resulted in poor vegetative growth favouring the incidence of pests and diseases[4,5].

The data pertaining to correlation of weather parameters during the years when the annual rainfall was >1000 mm (table 3 and Fig. 3) has indicated that the temperature had positive correlation with production and productivity. Rahman and Inden 2012 suggested that relatively higher temperature is better for sweet pepper production. Annual rainfall had positive correlation with production, while negative correlation was observed with productivity. Rainfall during south west monsoon and winter season had negative correlation with production and productivity. The negative correlation of rainfall during the period may be due to uneven distribution resulting in poor growth of the crop as chilli is sensitive to excess soil moisture. With regard to rainfall, distribution of rainfall is important parameter than amount of rainfall received. Excess rainfall during south west monsoon (35-45 days) and winter season (27.0 mm in a day) not only affected the crop growth and pod development and these conditions (Fig.3) might had increased the incidence of pest and diseases resulting in negative correlation. The even distribution of rainfall during north east monsoon (10-25 days) and summer season (4-10 days) resulted in fruit set and pod development resulting in positive correlation.

In the present study, sunshine hours had significant negative correlation with production and productivity irrespective of amount of rainfall. Maximum and minimum temperatures had positive correlation when rainfall is >750mm. The study indicated that the flowering and fruiting periods of the crop prefer minimum temperature and less sun shine hours, where as the vegetative growth prefers maximum temperatures and more sun shine hours.

The productivity of chilli was low during 1999-2000 (1879 kg/h). During this year the distribution of rainfall indicated that maximum amount of (75%) of rainfall was received during south west monsoon. This might had resulted in excess moisture during vegetative and flowering stages affecting the plant growth and fruit set. The poor vegetative growth and fruit set may be the cause for low yields during 1999-2000. The production of chilli was more during 2009-10 (5520 kg.ha), where the annual rainfall was 746.1mm. The distribution of rainfall during 2009-10 was 56-57% in south west monsoon, 25-30% during north east monsoon and in summer season it is 11-22%, with less (2.0.mm) rainfall during winter season resulting in maximum productivity of chilli. (Fig.4). The even distribution of rainfall during this year resulted in proper vegetative growth, fruit set and ultimately resulted in high yield. The study indicates that the distribution of rainfall plays a crucial role than amount of rainfall in determining the crop productivity.

Table - 1. Weather and seasonal distribution of rainfall on chilli production and productivity during 1999- 2012

Years	Mean max temp (^{0}C)	Mean min temp (0C)	Total Rainfall & distribution during 1999-2012		RF & distribution during SWM		RF &distribution during NEM		RF &distribution during winter		RF &distribution during summer		Sun shine hours (hrs/day)	Production "000" tons	Productivity (Kg/ha)
			Total Rainfall (mm)	No. of rainy days	RF during SWM (mm)	No. of rainy days	RF during NEM (mm)	No. of rainy days	winter (mm)	No. of rainy days	RF during	No. of rainy days			
1999-00	34.6	22.7	914.7	67	668.3	50	98.1	7	83.4	4	64.9	6	7.4	86	1879
2000-01	34.3	22.4	997.6	54	823.4	46	144	7	0	0	30.2	1	6.1	148	2942
2001-02	34.4	23	1019.8	48	668.8	30	220	11	27.5	1	103.5	6	7.1	204	3995
2002-03	34.7	22.7	534.1	34	285.1	25	202.9	7	0	0	46.1	2	6.6	119	2022
2003-04	34.2	23.3	1271.2	66	735.1	34	393.6	24	0	0	142.5	8	7	339	5042
2004-05	33.4	22.8	746.9	47	608.8	37	76.7	7	8.2	1	53.2	2	6.4	273	4911
2005-06	33.9	23.2	1046.5	53	655.1	34	232	19	0	0	159.4	0	6.7	194	4706
2006-07	31.8	21.8	744	60	450.2	34	241.6	19	1.0	0	51.2	7	6.6	286	4855
2007-08	33.4	22.7	1224.2	56	848.1	41	162.4	8	85.3	3	128.4	4	6	312	4926
2008-09	35.6	22.7	893.9	46	696.4	37	128.6	6	0	0	68.9	3	6.1	306	4996
2009-10	33.1	22.5	746.1	36	421.1	23	160.8	8	2.0	0	162.2	5	5.9	341	5520
2010-11	32.29	22.31	1367.9	70	977.7	46	258.7	19	115.3	0	16.2	5	6.1	206	3346
2011-12	34.9	23.2	874	54	626.2	42	62.8	7	146.6	3	38.4	2	5.8	332	4467

Table 2: Descriptive statistics of weather parameters in Guntur district during 1999-2012

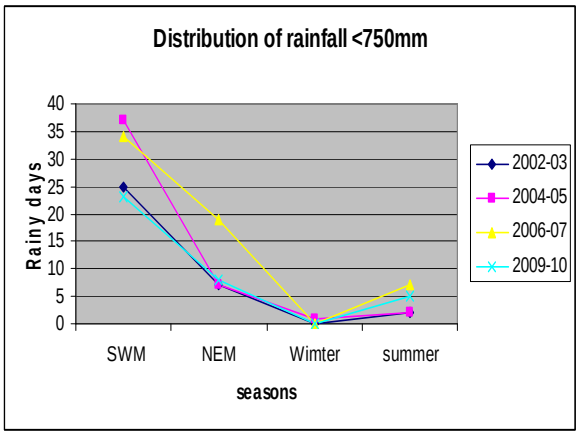
Weather parameter	Minimum	Maximum	Mean	Range	Standard Deviation
Mean max temp (0C)	31.80	35.60	33.89	3.80	1.07
Mean min temp (0C)	21.80	23.30	22.72	1.50	0.41
Total Rainfall (mm)	534.10	1367.90	952.38	833.80	237.66
Sun shine hours (hrs/day)	5.80	7.40	6.45	1.60	0.50
RF during SWM (mm)	285.10	977.70	651.10	692.60	185.86
RF during NEM (mm)	62.80	393.60	183.25	330.80	89.46
RF during winter (mm)	0.00	146.60	36.10	146.60	52.36
RF during summer (mm)	16.20	162.20	81.93	146.00	50.94
RF in crop season (mm)	488.00	1351.70	870.45	863.70	233.76
Production “000” tons	86.00	341.00	242.00	255.00	87.82
Productivity (Kg/ha)	1879.00	5520.00	4123.62	3641.00	1200.09

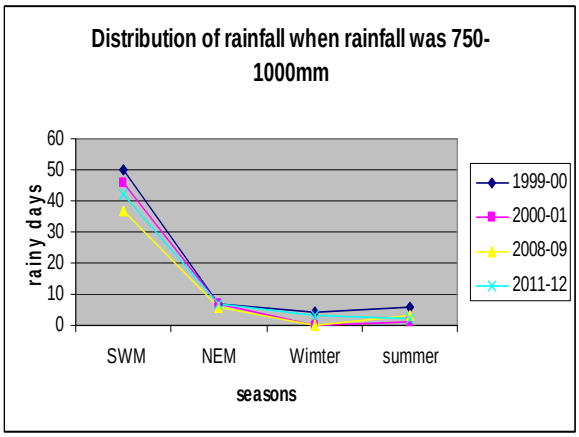
Table 3: Correlation coefficients of weather parameters with production and productivity of chilli in different rainfall situations

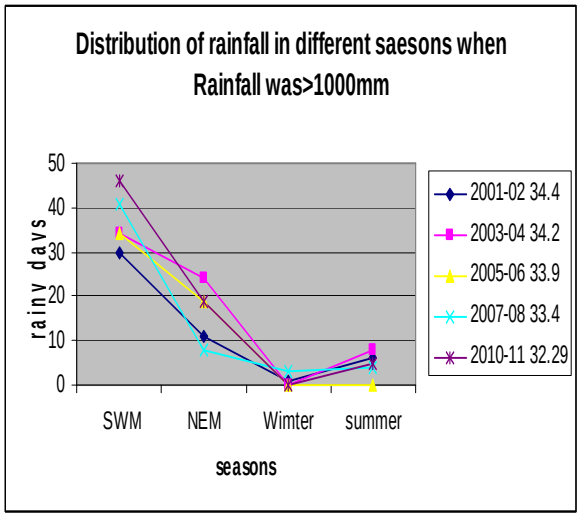
	Mean average rainfall <750 mm		Mean average rainfall 750 mm 1000 mm		Mean average rainfall >1000 mm	
Weather Parameters	Production “000” tons	Productivity (Kg/ha)	Production “000” tons	Productivity (Kg/ha)	Production “000” tons	Productivity (Kg/ha)
Mean max temp (C)	-0.743**	-0.751**	0.716**	0.791**	0.193	0.591**
Mean min temp (0C)	-0.338	-0.309	0.654**	0.449	0.250	0.714**
Total Rainfall (mm)	0.951**	0.982**	-0.629**	-0.509*	0.424	-0.216
Sun shine hours (h/d)	-0.679**	-0.613**	-0.802**	-0.809	-0.058	0.204
RF - SWM (mm)	0.601**	0.703**	-0.432	-0.262	0.098	-0.500*
RF -NEM (mm)	-0.234	-0.312	-0.353	-0.111	0.395	0.177
RF - winter (mm)	0.335	0.444	0.223	-0.032	-0.089	-0.590**
RF - summer(mm)	0.643**	0.552**	-0.035	0.046	0.367	0.911

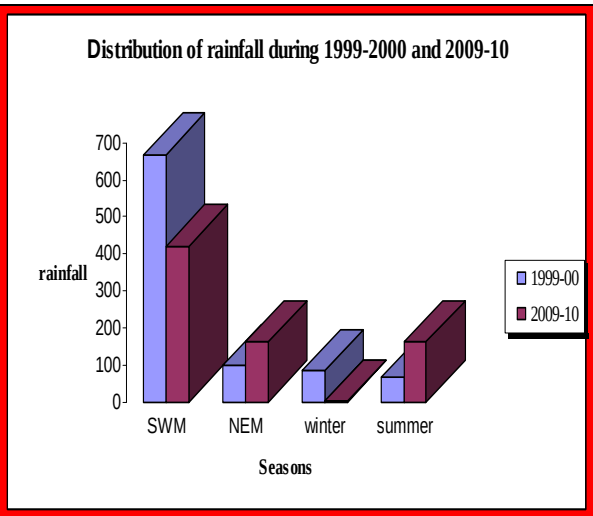
** Significant at 0.05% * Significant at 0.1%

Distribution of rainfall in different seasons (Fig.1,2,3) and distribution of rainfall during 1999-2000,2002-03,2003-04 and 2009-10 (Fig.4)









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