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To Compare the Effect of Weather on Growth, Development and Yield of Chickpea under Irrigated and Unirrigated Conditions

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ABSTRACT

The present investigation entitled “To compare the effect of weather on growth, development and yield of chickpea under irrigated and unirrigated conditions” was conducted during *rabi* season 2013-14 at Research Farm of Indira Gandhi Krishi Vishwavidyalaya, Raipur (Chhattisgarh). Studies were carried out on different phenological stages right from sowing to harvesting under irrigated and unirrigated conditions in the three dates of sowing. Based on the duration of different phenological stages the average maximum and minimum temperatures at different growth stages in the different dates of sowing were worked out. For comparative analysis Stevenson screen was installed in the crop field and the average maximum and minimum temperatures at different growth stages were also worked out using the field data. The duration for sowing to germination, Grand growth, Bud formation, first flowering, 50 % flowering, pod development and physiological maturity for three different dates of sowings under irrigated and un irrigated condition was recorded and analyzed. It was found that from first flowering to 50% flowering onwards the duration under different dates of sowing in unirrigated condition is less when compared to irrigated condition. The average maximum temperature under D₁ in the germination to grand growth stage is higher in the first date of sowing. However, later on that is from grand growth to bud formation the maximum temperature is higher in D₁ as compare to D₂ and D₃ both in field as well as observatory data.

Keywords

Growth, Development,
Yield of chickpea,
Weather, Temperature

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Introduction

Climate and weather conditions which influence human activities and environmental resources sustainability include; rainfall, temperature (minimum, average, maximum), pressure, humidity, solar radiation, visibility, evaporation, soil temperature at various depths, wind speed and direction among others. The climate is the least manageable

part of environmental resources, yet a better understanding of the climatic resources and their interaction with crops can help to increase the crop productivity.

Plant development depends on temperature and requires a specific amount of heat to develop from one point in their lifecycle to another, such as from seeding to the harvest stage. Temperature is a key factor for the

timing of biological processes and hence regulates the growth and development of plants. Crop heat unit (CHU) or thermal time or growing degree days is a temperature response of development that differs between day and night. Growing degree days is a way of assigning a heat value to each day. Heat units are involved in several physiological processes like specific amount of heat units required for the plant at each stage from its germination to harvest of the crop and they would vary. The important processes are growth and development, growth parameters, metabolism, biomass, physiological maturity and yield. Growing degree days are used to assess the suitability of a region for production of a particular crop, determine the growth stages of crops, assess the best timing of fertilizer, herbicide and plant growth regulators application, estimate heat stress accumulation on crops, predict physiological maturity and harvest dates and ideal weather unit in constructing crop weather models (Parthasarathi *et al.*, 2013).

The chickpea grain yield is related to its phenology which is influenced by temperature. The timing and duration of flowering has an important role in determining crop duration and grain yield at high temperature. The crop is forced into maturity under hot and dry condition ($>30^{\circ}\text{C}$) by reducing the crop duration (Summerfield *et al.*, 1984).

Materials and Methods

The present study entitled “Studies on the effect of weather and irrigation on growth, development and yields of chickpea under Raipur conditions.” was conducted during the *rabi* season of 2013-14. The details of experimental soil, prevailing weather conditions, materials used and techniques adopted during the course of the investigation are briefly presented in this chapter.

Location of experimental site

The field experiment was conducted at the research farm, Indira Gandhi Krishi Vishwavidyalaya; Raipur situated in South Eastern Central part of Chhattisgarh at latitude, longitude and altitude of $21^{\circ}16''$ N, longitude $81^{\circ}36''$ E and 289.5 m above mean sea level respectively.

Climate

The climate of Chhattisgarh state is dry sub humid. Nearly 90 % of the annual average rainfall occurs from June to September during south west monsoon.

During the growth period the maximum temperature ranged between 22°C to 36.3°C while minimum temperature ranged between 8 and 20.7°C .

The morning relative humidity varied from 59 to 100% whereas. The afternoon humidity varied from 20 to 83 % (47 SMW and 12 SMW).

Experimental detail

The details of the treatments are given below and experimental lay out is shown in Figure 1. The cropping history of the experimental field is furnished in Table 1.

Soil

The soil of the experimental site is clay loam in texture of (Alfisol group) locally known as “Dorsa” The soil was neutral in reaction and had low phosphorous medium nitrogen and potassium content.

Variety

JG-130: This cultivar is suitable for rainfed as well as irrigated conditions.

Field preparation

The field was ploughed twice with tractor and weeds were removed. Then it was leveled with the help of tractor driven leveler.

Fertilizer application

Fertilizer was applied to the crop as per recommended dose of nitrogen, phosphorus and potash i.e., 20:40:20 (N: P: K) Kg/ha full dose of N: P: K was applied as basal dose before sowing in rows.

Seed rate and sowing

After field preparation, the sowing was done in line at a distance of 10 X 10 cm plant to plant and 30 X 30 cm row to row distance. The sowing was done with a seed rate of 80 kg /ha.

Harvesting

The crop was harvested manually on different dates with the help of sickle from 11 March to 03 April when the crop attained full maturity. Two rows from the either side of each plot and 50 cm from other two ends were harvested separately and removed as border.

The produce of each net plot was tied into bundle and allowed to sun drying in respective plots.

The harvested bundles were weighted with the help of spring balance and transported to threshing floor.

Irrigation

Only one irrigation (Excluding pre sowing irrigation) was given to the crop under irrigation treatment. Under irrigated condition first irrigation was given at 45 days after sowing.

Harvesting and threshing

Harvesting was done for different dates of sowing under irrigated and unirrigated conditions as per maturity of the crop. The data were recorded in the 10 selected plot of 1 m² area.

Threshing was done after two days sun drying and then grain were cleaned and weighted for each plot in each treatment.

Results and Discussion

The present investigation was carried with three different environments for the chickpea crop to study the effect of weather on crop growth and development and yield of chickpea.

Weather data was collected both from crop field and nearby weather station right from first date of sowing to harvesting. The daily weather data collected from crop field and experimental field

Weather condition during crop growth period

For analysis of data, weekly averages based on standard meteorological weeks were worked out for both observatory and field and they are shown in Table 2 and 3. When the data are compared it was found that in the initial weeks the field data and observatory data were the same in respect of dry bulb temperature both in morning and evening hours. Later from third week onwards the dry bulb temperature in the field was lower by 0.2 to 0.4 °C. However, when the maximum temperature was examined it was found that the maximum temperature in the observatory is higher than the field observatory by 0.2 to 0.6 °C throughout the growing season. Similarly the minimum temperature was also higher in the observatory when compared to field data.

Fig.1 Layout plan of experimental chickpea field

Plate 1: Field site with board

Experimental Detail

Season	: Rabi-2013-14
Crop	: chickpea (<i>cicer arietinum</i>)
Variety	: JG-130
Dates of Sowing	: Three
	: D ₁ – 20 Nov. 2013
	: D ₂ – 30 Nov 2013
	: D ₃ – 10 Dec. 2013
Soil	: Clay loam
Seed rate	: 80 kg/ha
Fertilizer doses	: 20:40:20 kg/ha. N: P ₂ O ₅ :K ₂ O
Spacing	: 30 cm X 10 cm
Total number of plots	: 6
Total plot area	:120 m ²
Total experimental area	:782.0 m ²
Plot to plot distance	:0.5 m
Statistical analysis	: ‘t’ test

Table.1 Cropping history of the experimental field

Year	Crop	
	<i>Kharif</i>	<i>Rabi</i>
2011-12	Rice	Wheat
2012-13	Rice	Wheat
2013-14	Rice	Chickpea

Table.2 March of weekly meteorological parameters recorded in the experimental field during *rabi* season 2013-14 at Labhandi, Raipur

Week No.	Date	Dry bulb temperature (°C) I	Wet bulb temperature (°C) I	Dry bulb temperature (°C) II	Wet bulb temperature (°C) II	Maximum Temperature (°C)	Minimum temperature (°C)	Relative humidity (%) I	Relative humidity (%) II
47	November 19-25	17.7	16.5	29.4	20.3	30.3	16.7	87.0	40.3
48	26-02	16.9	15.2	28.8	20.4	29.6	14.8	82.4	43.9
49	December 03-09	12.7	12.0	26.7	17.0	27.8	11.1	90.7	32.9
50	10-16	10.9	10.0	26.4	16.3	27.5	9.2	85.6	30.1
51	17-23	12.6	11.7	27.2	17.5	28.1	10.9	89.7	33.4
52	24-31	13.2	12.6	26.8	18.7	28.0	12.0	94.0	43.3
1	January 01-07	13.9	13.3	27.0	18.6	28.4	12.2	93.9	27.4
2	08-14	14.2	13.4	27.7	19.9	27.6	13.0	91.0	28.0
3	15-21	16.6	15.7	26.7	19.4	27.9	15.4	89.6	27.0
4	22-28	14.3	13.3	26.3	17.4	28.0	13.0	87.7	26.6
5	29-04	10.3	9.5	28.0	17.9	28.7	9.1	89.4	27.9
6	February 05-11	14.9	13.9	30.0	20.1	30.9	13.6	88.1	30.3
7	12-18	16.4	14.4	25.8	17.7	27.7	14.9	79.0	43.3
8	19-25	15.2	14.2	28.6	21.2	28.7	13.7	90.0	44.7
9	26-04	18.3	17.6	26.0	20.1	27.8	17.4	93.4	62.6
10	March 05-11	18.7	17.7	27.7	20.4	27.2	16.9	89.6	50.1
11	12-18	20.7	19.6	33.1	22.6	33.1	18.6	88.7	39.4
12	19-25	21.5	18.9	35.9	20.9	36.2	18.9	76.4	22.4

Table.3 March of weekly meteorological parameters recorded at agromet observatory during *rabi* season 2013-14 at Labhandi, Raipur

Week No.	Date	Dry bulb temperature (°C) I	Wet bulb temperature (°C) I	Dry bulb temperature (°C) II	Wet bulb temperature (°C) II	Maximum Temperature (°C)	Minimum Temperature (°C)	Relative humidity (%) I	Relative humidity (%) II
47	November 19-25	17.7	16.5	29.4	20.3	30.3	16.7	87.0	40.3
48	26-02	16.7	15.1	28.8	19.3	30.2	15.6	83.0	34.9
49	December 03-09	13.2	12.4	26.8	16.7	28.4	11.8	90.6	31.4
50	10-16	11.1	10.4	26.8	16.2	28.0	9.8	90.0	27.3
51	17-23	12.9	12.2	27.2	17.9	28.3	11.7	90.1	33.7
52	24-31	13.5	13.0	27.1	18.6	28.4	12.7	92.8	40.0
1	January 01-07	14.5	13.6	27.4	18.7	28.7	13.4	89.7	40.4
2	08-14	14.9	14.2	28.1	20.2	27.8	14.1	90.1	46.9
3	15-21	17.0	16.2	27.1	19.6	29.0	16.0	88.9	45.9
4	22-28	14.5	13.4	26.7	17.9	28.4	13.6	87.1	37.9
5	29-04	11.1	10.1	28.1	17.2	28.8	9.6	86.3	26.4
6	February 05-11	15.6	14.3	30.4	19.8	31.6	14.7	84.9	33.3
7	12-18	16.3	16.0	26.1	17.8	27.9	15.3	82.7	38.7
8	19-25	15.8	15.8	28.7	19.9	28.9	14.6	85.9	40.7
9	26-04	18.5	18.1	25.3	20.1	27.9	17.7	90.7	58.3
10	March 05-11	19.1	17.8	27.7	19.8	27.5	17.5	87.6	44.6
11	12-18	20.9	19.8	33.1	22.8	33.3	20.9	88.9	38.3
12	19-25	21.6	18.8	35.6	20.8	35.8	19.8	72.9	20.9

Table.4 Phenological observations in chickpea crop for three different dates of sowing under irrigated and unirrigated conditions

S. N.	Particular	DAS		Dates of observations		
				Irrigated	Unirrigated	
1	Dates of sowing	D ₁	0	20/11/2013	0	20/11/2013
		D ₂	0	30/11/2013	0	30/11/2013
		D ₃	0	10/12/2013	0	10/12/2013
2	Dates of Germination	D ₁	5	25/11/2013	5	25/11/2013
		D ₂	7	07/12/2013	7	07/12/2013
		D ₃	9	19/12/2013	9	19/12/2013
3	Dates of Grand growth	D ₁	18	08/12/2013	18	08/12/2013
		D ₂	23	23/12/2013	22	22/12/2013
		D ₃	31	10/01/2014	31	10/01/2014
4	Dates of Bud formation	D ₁	44	03/01/2014	44	03/01/2014
		D ₂	46	15/01/2014	47	16/01/2014
		D ₃	41	20/01/2014	41	20/01/2014
5	Dates of First flowering	D ₁	45	04/01/2014	46	05/01/2014
		D ₂	48	17/01/2014	48	17/01/2014
		D ₃	44	23/01/2014	43	22/01/2014
6	Dates of 50% flowering	D ₁	59	19/01/2014	55	14/01/2014
		D ₂	58	27/01/2014	53	22/01/2014
		D ₃	55	02/02/2014	47	26/01/2014
7	Dates of Pod development	D ₁	69	28/01/2014	69	18/01/2014
		D ₂	65	03/02/2014	60	29/01/2014
		D ₃	59	07/02/2014	54	02/02/2014
8	Harvest	D ₁	107	07/03/2014	98	21/02/2014
		D ₂	105	15/03/2014	98	08/03/2014
		D ₃	103	23/03/2014	84	04/03/2014

Table.5 Mean maximum temperature at different phenological stages based on observatory and field data in the Three different dates of sowing

Dates of sowing	Phenological stages						
	Sowing to germination	Germination to grand growth	Grand growth to bud formation	Bud formation to first flowering	First flowering to 50% flowering	50% flowering to pod development	Pod development to physiological maturity
D₁ Observatory	37.8	29.8	28.2	28.5	28.6	28.2	28.0
D₁ Field	37.8	29.1	27.9	28.5	28.0	28.0	27.8
D₂ observatory	34.8	27.9	28.3	29.5	28.6	28.4	29.2
D₂ Field	34.1	27.6	28.0	29.4	27.7	28.1	28.9
D₃ observatory	31.6	28.4	28.5	29.0	28.1	30.2	30.2
D₃ Field	31.1	28.1	27.8	28.7	27.8	29.8	29.9

Table.6 Mean minimum temperatures at different phenological stages based on observatory and field data in Three different dates of sowing

Dates of sowing	Phenological stages						
	Sowing to germination	Germination to grand growth	Grand growth to bud formation	Bud formation to first flowering	First flowering to 50% flowering	50% flowering to pod development	Pod development to physiological maturity
D₁ Observatory	21.6	14.6	11.5	12.9	14.6	14.8	13.9
D₁ Field	21.0	14.0	10.8	12.0	13.5	14.2	13.4
D₂ observatory	17.3	24.1	13.3	15.3	15.4	9.9	16.2
D₂ Field	16.5	9.8	12.4	14.6	14.8	9.4	15.3
D₃ observatory	11.2	12.8	15.5	14.7	12.0	10.7	17.2
D₃ Field	10.5	11.9	14.6	14.1	11.4	10.3	16.3

The relative humidity both in morning and afternoon hours was higher in the chickpea field, when compared to observatory. The march of maximum and minimum temperatures and relative humidity in the field as well as observatory are shown in Figure 2. It is observed from the figure that the range of temperature as well as relative humidity is higher during the crop growing season. This higher range of temperature is responsible for the lower productivity of chickpea in this region.

Average temperature conditions on different dates of sowing

Maximum temperature

Based on phenological observations the average maximum temperature and minimum temperature during different growth stages in different dates of sowing are shown in Table 5. The average maximum temperature under D₁ in the germination to grand growth stage is higher in the first date of sowing. However, later on that is from grand growth to bud formation the maximum temperature is higher in D₃ as compare to D₂ and D₁ both in field as well as observatory. The average maximum temperature varied from 37.8 °C to 28.0°C under first date of sowing. In the second date of sowing the maximum temperature varied from 34.8 to 29.2°C, in the observatory data. In the field data it varied from 37.8 to 27.8°C in first date of sowing and from 34.1 to 28.9°C in the second date of sowing. In the third date of sowing the maximum temperature varied from 31.6 to 28.1°C in observatory data while in the field data it varied from 31.1 to 27.8°C.

Minimum temperature

The minimum temperature at different growth stages based on both field and observatory data is shown in table 6. The minimum

temperature in the first date of sowing varied from 21.6°C to 11.5 °C under different phenological stages based on observatory data.

While in the field data it varied from 21.0°C to 10.8°C during different growth stages. In the second date of sowing the minimum temperature based on observatory data varied from 24.1°C to 9.9°C while, in the field data it varied from 16.5°C to 9.4°C in different growth stages. In the third date of sowing the minimum temperature varied from 10.7°C to 17.2°C in different growth stages based on the observatory data, while based on the field data the minimum temperature varied from 10.3°C to 16.3°C in different growth stages.

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