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Effect of time of sowing on growth, yield attributes, yield of chickpea

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Abstract
The present investigation entitled Effect of time of sowing on growth, yield attributes, yield of chickpea. 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 workout. For comparative analysis Stevenson screen was installed in the crop field and the average maximum and minimum temperatures at different growth stages were also workout using the field data.

The number of seed /m^2 difference between D_1 and D_2 under irrigated condition is very highly significance. The difference between D_1 unirrigated and D_2 unirrigated is not significant. In other treatments the difference is highly significant. Thus the sowing data under unirrigated conditions could be extended till 20th November under Raipur conditions.

The grain yield (gm/m^2) difference between D_1 irrigated and D_2 irrigated is highly significant but the difference between D_1 unirrigated and D_2 unirrigated is not significance. In D_1 unirrigated and D_3 unirrigated and D_2 unirrigated and D_3 unirrigated conditions the difference in yield is highly significant. This indicates that under unirrigated condition sowing should not be done after 30th November. Among irrigated conditions the difference between D_2 irrigated and D_3 irrigated is also highly significant.

Difference between D_1 and D_2 unirrigated condition and between D_2 and D_3 irrigated condition are not significant. In the other treatments it is significant. This is the reason that the grain yield under these two treatments is not significant. However, D_2 and D_3 under irrigated condition the grain yield is highly significant but the test weight is not significant.

The highest dry matter accumulation was observed at maturity in D_1 irrigated (777.2 gm/m^2) treatment followed by D_1 unirrigated, D_2 irrigated and unirrigated. Lowest dry matter accumulation was observed in D_3 under unirrigated (248.2 gm/m^2). Dry matter production reached almost plateau during maturity of the crop.

Keywords: yield, chickpea, grain, weight

Introduction
In Chhattisgarh also chickpea is a very important *rabi* crop grown under rainfed and limited irrigation conditions. It is grown in about 3.5 lakh hectare with an average productivity of one quintal per hectare. This crop is sown from second fortnight of October to first week of December. Thus the crop is exposed to different weather conditions. 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 (>30ºC) by reducing the crop duration.

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).

Material and Methods

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 $21^0$16'' N, longitude $81^0$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 22^0C to 36.3^0C while minimum temperature ranged between 8 to 20.7^0C. The morning relative humidity varied from 59 to 100% whereas. The afternoon humidity varied from 20 to 83 % (47 SMW and 12 SMW)

Table 3.1: Cropping history of the experimental field

Year	Crop	
	Kharif	Rabi
2011-12	Rice	Wheat
2012-13	Rice	Wheat
2013-14	Rice	Chickpea

Experimental Detail

The details of the treatments are given below and experimental lay out is shown in Fig. 3.1.The cropping history of the experimental field is furnished in Table 3.1.

Season : *Rabi*-2013-14
Crop : chickpea (*Cicer arietinum*)
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_2O_5:K_2O
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

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 condition

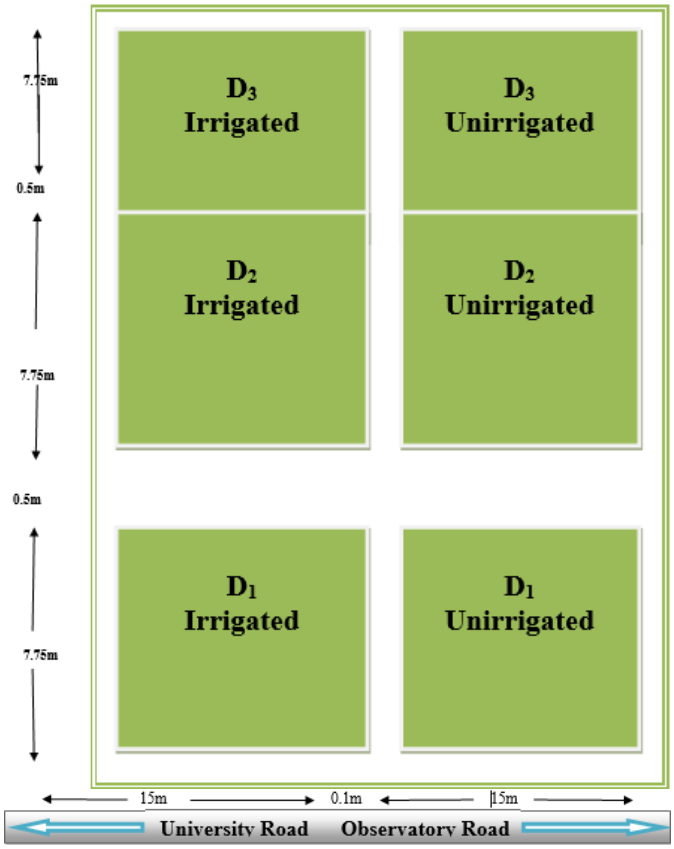


Fig 3.1: Layout plan of Experimental chickpea field

Dry matter accumulation

The dry matter production was recorded at 7 days interval from 30 days after sowing to harvest by selecting 5 plants each time and average dry matter production per plant was workout. This was multiplied by the plant population in each field to obtain the dry matter production per m^2.

Post harvest observations

Number of seeds /m^2

In 10 plots of 1 m^2 each area the numbers of seeds were counted and then average values were recorded.

Grain yield (g/m^2)

The grain yield was recorded in 10 plots of 1 m^2 area and then averaged for each treatment.

Test weight (100-seed weight)

Randomly 100 seed samples were taken from each plot in each treatment.

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.

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.

Results and Discussion
Yield and yield attributes
The yield and other important yield attributes of chickpea under three dates of sowing in irrigated and unirrigated fields were measured and the results are discussed below:

Number of seeds/m^2
The number of seeds/m^2 under different dates of sowing in irrigated and unirrigated conditions for each plot is shown in Table 4.15. It can be seen from the table that the mean no. of seed /m^2 are very high (1210) as compare to other treatments. The difference between irrigated condition even in D_1 and D_2 is very high and that is why, there is high significance between treatments even in grain yield. The difference between D_1 unirrigated and D_2 unirrigated is relatively small and hence, the difference is not significant. In other treatments the difference is highly significant. For examining the significance of difference between different treatments 't' test was conducted. The t test results for number of seed/m^2 under different treatments it carried out and the results are under shown in next page.

Table 4.15: Number of seeds /m^2 of chickpea under different sowing dates in irrigated and unirrigated conditions.

Date of sowing	Irrigation	Plot no.										Mean
		1	2	3	4	5	6	7	8	9	10	
D_1	Irrigated	1299	1216	1244	1120	1069	1213	1247	1191	1279	1229	1210.7
	Un irrigated	467	619	767	508	773	489	421	622	699	384	574.9
D_2	Irrigated	721	740	698	693	802	761	647	705	645	651	706.3
	Un irrigated	491	523	563	408	498	405	442	442	540	466	477.8
D_3	Irrigated	436	498	416	465	422	391	437	483	413	481	444.2
	Un irrigated	236	277	276	216	241	277	242	287	261	277	259.0

Description	t test value
D_1 irrigated vs D_2 irrigated.	14.78**
D_1 unirrigated vs D_2 unirrigated.	2.72
D_1 irrigated vs D_3 irrigated.	29.49**
D_1 unirrigated vs D_3 unirrigated.	7.17**
D_2 irrigated vs D_3 irrigated.	12.17**
D_2 unirrigated vs D_3 unirrigated	12.85**

It can be seen from the above in D_1 and D_2 under unirrigated conditions the different between number of seed /m^2 is not significant. In the other words the number of seed /m^2 is more or less the same as unirrigated condition in D_1 and D_2 dates of sowing. In other treatments there is significant difference between the treatments and this is exactly the same way as in grain yield weight.

Grain yield
The grain yield (gm/m^2) of chickpea under different dates of sowing in irrigated and unirrigated treatments are shown in Table 4.16. The observations were recorded in 10 plots of 1m^2 area each and the values were averaged. It can be seen from the Table that under D_1 irrigated condition the mean value of grain weight is 353 gm/m^2 which is higher as compared to other treatments. In D_1 unirrigated condition the average grain yield was 153 gm/m^2. In D_2 field the grain yield under irrigated and unirrigated condition were 187.0 and 129.9 gm/m^2 respectively. In D_3 the grain yield was 121.1 gm/m^2 in irrigated field and it is only 53.8 gm/m^2 in unirrigated conditions. To find out the significance of results t test was conducted and the results are as shown below

Description	t test value
D_1 irrigated vs D_2 irrigated	18.32**
D_1 unirrigated vs D_2 un irrigated	2.73 NS
D_1 irrigated vs D_3 irrigated	32.27**
D_1 unirrigated vs D_3 un irrigated	8.63**
D_2 irrigated vs D_3 irrigated	12.29**
D_2 unirrigated vs D_3 un irrigated	16.53**

From the Table it can be observed that the difference between D_1 irrigated and D_2 irrigated is highly significant but the difference between D_1 unirrigated and D_2 unirrigated is not significance. In D_1 unirrigated and D_3 unirrigated, D_2 unirrigated and D_3 unirrigated the difference in yield is highly significant. This indicates that under unirrigated condition sowing should not be done after 30th November. Among irrigated conditions the difference between D_2 irrigated and D_3 irrigated is also highly significant. This indicates that even under irrigated condition the sowing should not be done beyond November 30.

Test weight
The 100 seed test weight (gm) of chickpea under different dates of sowing in irrigated and unirrigated conditions in 10 different plots was recorded and their means are shown in Table 4.17. It can be seen from the table that test weight was 29.3 and 27.0 gm in D_1 under irrigated and unirrigated conditions. In D_1 the test weight is 27.3 and 26.6 (gm) in irrigated and unirrigated condition respectively. In case of D_3, the test weight is 27.2 and 26.2 in irrigated and unirrigated conditions. For understanding the significance of the different in test weight t test was conducted and the results are as follows:

Description	t-test value
D_1 irrigated vs D_2 irrigated.	4.91**
D_1 unirrigated vs D_2 unirrigated.	1.34 NS
D_1 irrigated vs D_3 irrigated.	7.16**
D_1 unirrigated vs D_3 unirrigated.	19.92**
D_2 irrigated vs D_3 irrigated.	0.63 NS
D_2 unirrigated vs D_3 unirrigated.	16.80**

From the above it can be observed that test weight difference between D_1 and D_2 unirrigated condition and between D_2 and D_3 irrigated condition are not significant. In the other

treatments it is significant. This is the reason that the grain yield under these two treatments is not significant. However, D_2 and D_3 under irrigated condition the grain yield is highly significant but the test weight is not significant. The number of seed /m^2 is highly significant between D_2 and D_3 irrigated and hence the grain yield is also highly significant between these two treatments.

Table 4.16: Grain yield (gm/m^2) of chickpea under different sowing dates in irrigated and unirrigated conditions.

Date of sowing	Irrigation	Plot no.										Mean
		1	2	3	4	5	6	7	8	9	10	
D_1	Irrigated	356.3	362.5	366.1	327.5	310.2	357.4	366.7	351.8	378.7	361.4	353.8
	Unirrigated	125.9	165.7	207.4	135.8	207.6	130.3	111.1	166.5	182.6	102.5	153.5
D_2	Irrigated	191.5	198.1	188.0	183.6	204.2	202.3	171.5	187.1	170.9	172.6	187.0
	Unirrigated	131.6	141.3	152.5	110.7	135.4	111.2	120.0	123.1	146.4	126.8	129.9
D_3	Irrigated	118.8	135.5	115.7	126.4	114.4	106.8	119.3	131.3	112.8	130.6	121.1
	Unirrigated	49.5	58.1	56.0	46.0	48.8	58.0	50.7	60.8	52.9	57.0	53.8

Dry matter production dynamics

The dry matter production from 30 days after sowing to harvest was studied at weekly intervals both under irrigated and unirrigated conditions in different dates of sowing and the results are shown in Table 4.18 and Figure 4.4. It can be seen from the table and figure that the dry matter accumulation increased at faster rate in D_1 as compared to D_2 right from 10 days after sowing and continued till the maturity of the crop. However, the dry matter accumulation was lower in D_3 as compared to D_1 and D_2 in both irrigated and unirrigated sowing conditions at all the crop growth stages.

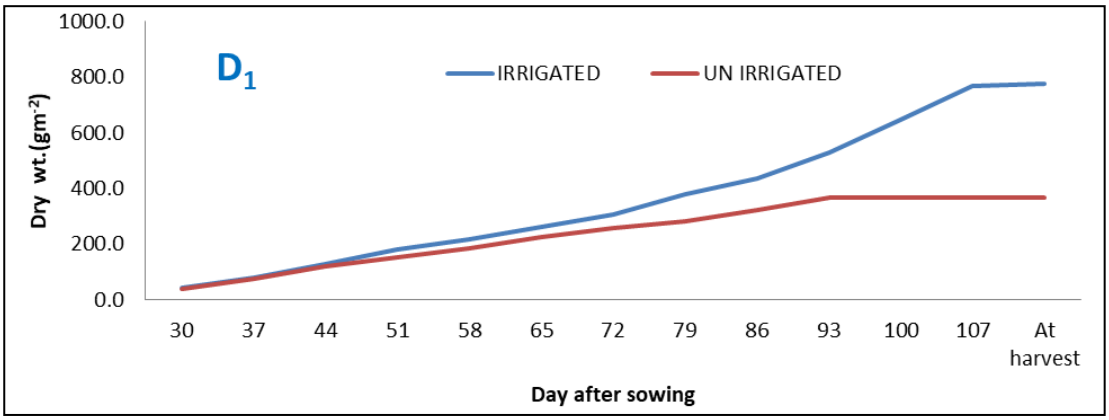
Further it was observed that the rate of increase in dry matter was slow up to 30 days after sowing and then increased rapidly between 30 to 51 days after sowing. After 50 days flowering to harvesting the rate of increase in dry matter abruptly increased in most of the irrigated conditions and this trend was continued up to maturity. The highest dry matter accumulation was observed at maturity in D_1 irrigated (777.2 gm/m^2) treatment followed by D_1 unirrigated, D_2 irrigated and unirrigated. Whereas lowest dry matter accumulation was observed in D_3 unirrigated (248.2 gm/m^2). Dry matter production reached almost plateau during maturity of the crop.

Table 4.17: Test weight of 100 seeds (gm.) of chickpea under different sowing dates.

Date of sowing	Irrigation	Plot no.										Mean
		1	2	3	4	5	6	7	8	9	10	
D_1	Irrigated	29.8	28.4	29.7	28.2	29.7	29.7	28.2	29.8	30.2	29.7	29.3
	Un irrigated	26.9	27.2	26.7	27.0	26.2	26.8	26.6	27.2	27.5	27.5	27.0
D_2	Irrigated	27.2	28.8	27.8	26.2	26.5	28.4	27.8	26.7	28.3	26.2	27.3
	Un irrigated	26.5	26.3	26.3	26.4	28.0	26.2	26.5	27.1	26.2	26.5	26.6
D_3	Irrigated	27.2	28.3	27.8	26.2	27.6	28.1	26.5	26.7	27.0	26.5	27.2
	Un irrigated	19.0	21.1	20.3	22.3	21.3	20.7	19.3	20.0	21.0	21.4	26.0

Table 4.18: Dry matter production (gm/m^2) of chickpea under different sowing dates and in irrigated and unirrigated conditions.

Dates of sowing	Irrigation	Days after sowing												
		30	37	44	51	58	65	72	79	86	93	100	107	At harvest
D_1	Irrigated	40.6	78.3	127.6	179.8	217.5	261.0	304.5	345.1	485.7	527.8	646.7	768.5	777.2
	Unirrigated	39.0	75.4	119.6	153.4	184.6	223.6	257.4	280.0	322.4	366.6	366.0	366.6	366.0
D_2	Irrigated	29.0	48.0	74.0	91.2	151.2	204.0	283.2	329.0	365.0	444.0	473.0	473.0	473.0
	Unirrigated	28.8	47.7	73.8	88.2	104	128.0	166.0	207.0	239.0	243.0	243.0	243.0	243.0
D_3	Irrigated	16.6	42.0	68.0	88.0	116.0	146.0	176.0	210.0	238.0	261.6	278.8	296.0	296.0
	Unirrigated	15.3	31.9	54.0	68.0	93.5	108.8	120.7	163.2	204.0	227.8	248.2	248.2	248.2



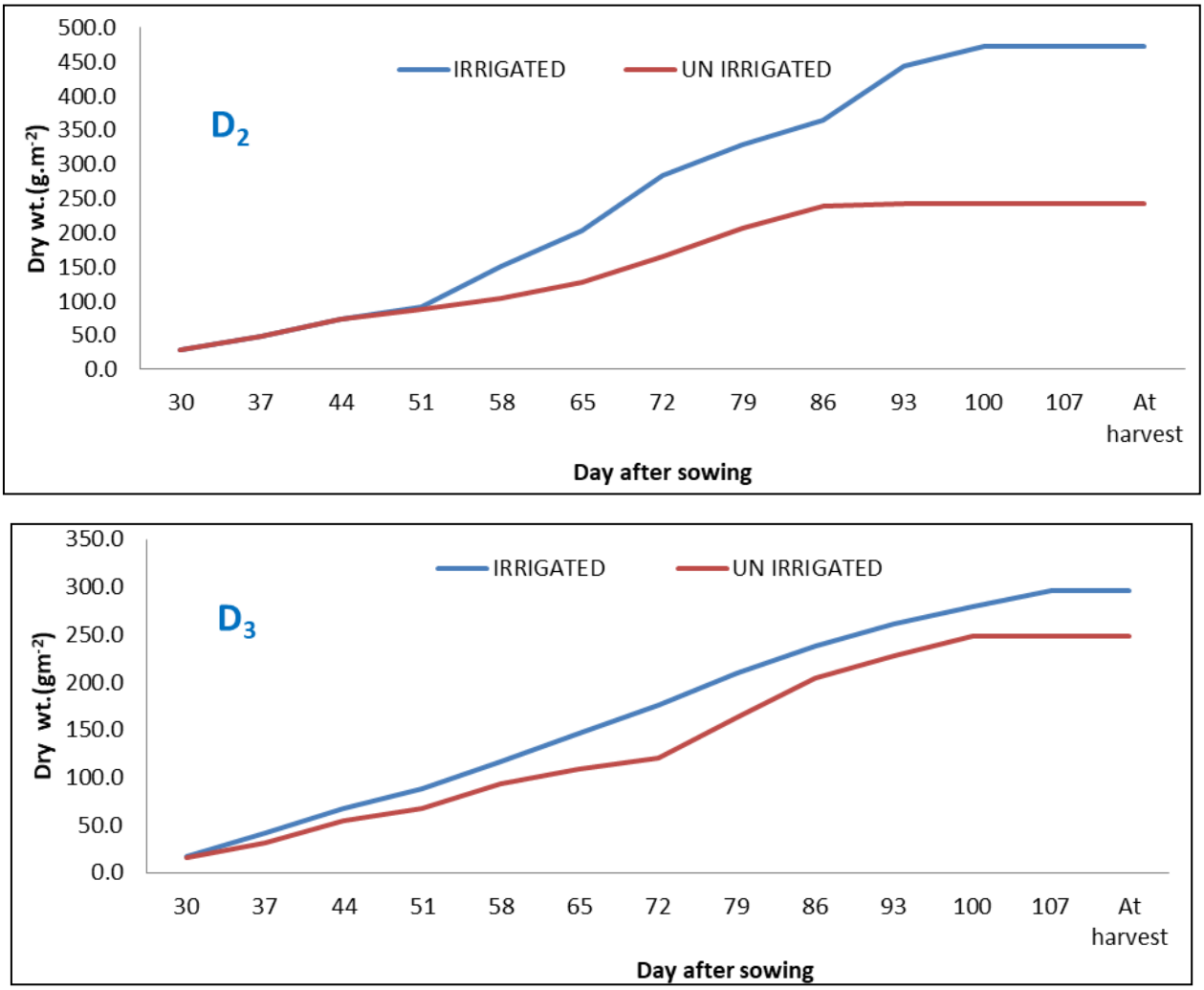


Fig 4.4: Dry matter production (gm/m^2) of chickpea at 7 Days interval under different dates of sowing under irrigated and un irrigated conditions

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