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Original Research Article

Studies on Accumulated Thermal Unit and Radiation Use Efficiency at Different Phenophases of Chickpea (*Cicer arietinum* L.) Cultivars under Different Growing Environment

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Chickpea, Growing environment, Radiation use efficiency, Thermal unit

A B S T R A C T

A field experiment was conducted during rabi season of 2017-18 entitled "Studies on accumulated thermal unit and radiation use efficiency at different phenophases of chickpea cultivars under different growing environment" at Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya (U.P.). The experiment was conducted in factorial Randomized Block Design with consist of nine treatment combinations comprised three growing environments viz., sowing on Nov. 5th (D_1) with temperature 23.8°C, Nov 15th (D_2) with temperature 20.8°C and Nov. 25th (D_3) with temperature 16.8°C and three varieties viz., Uday (V_1), Pusa-362 (V_2) and Radhey (V_3) along with four replication. Heat unit (2172°C days) and radiation use efficiency (1.58 g M J^{-1}) were recorded highest under growing environment Nov. 5th (D_1) with temperature 23.8°C followed by growing environment of Nov.15th (D_2) with temperature 20.8°C, while lowest heat unit (2012°C days) and radiation use efficiency (1.56 g MJ^{-1}) were recorded under growing environment Nov. 25th (D_3) with temperature 16.8°C. Uday (V_1) cultivar was found more conducive and remunerative for growth and seed yield as compare to other cultivars of chickpea.

Introduction

Chickpea (*Cicer arietinum* L.) is the common name for an annual plant of the fabaceae family that is widely cultivated for its typically yellow-brown, pea like seeds. This light brown colored pulse is considered to be a good source of protein. Seed of chickpea are used as edible seed and also used for making flour throughout the globe. Chickpea crop is having a capacity to stand in drought conditions. India is the major chickpea (gram/chana) producing country. Chickpea crop is basically grown in the dry regions of India (FAO, 2013).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 would vary and 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 heat unit concept assumes that a direct and linear relationship between growth and temperature is advantageous for the assessment of yield potential of a crop in different weather conditions. Keeping above facts in view present investigation was under taken.

Materials and Methods

A field experiment was conducted at Acharya N. D. University of Agriculture & Technology, Kumarganj, Ayodhya (U.P.) during *rabi* season of 2017-18 which lies at latitude 26° 47'North longitude 82°12' East and altitude of 113 meter from mean sea level in the Indo -genetic alluvium of Eastern Uttar Pradesh. The experiment was carried out in Randomized Block Design (Factorial) and replicated four times. The experiment comprised three growing environments i.e. Nov. 5th with temperature 23.8^{0}C, Nov 15th with temperature 20.8^{0}C and Nov. 25th with temperature 16.8^{0}C and three cultivars i.e. Uday, Pusa-362 and Radhey. Recommended dose of fertilizer viz., nitrogen and phosphorus ware applied at the rate of 20:40 kg ha^{-1} respectively. The whole quantity of nitrogen and P_2O_5 were applied as basal dose at the time of sowing of the crop. The soil of the experimental field was silty loam in texture and medium in fertility having p^{H} 8.0.Total numbers of days taken from seed sowing to different phenophases of chickpea crop were recorded as to know the effect of various treatments on the phenophasic duration of crop.

Accumulated thermal unit of different phenophases were calculated by using following formula;

$$ATU = \sum_{i=1}^{n} G.D.D.$$

Where,
i= 1, 2, 3…….. n is the number of day.

$$\text{Accumulated thermal unit} = \frac{T\max + T\min}{2} - \text{Base temp.}$$

Base temperature for chickpea crop is 5°C.

Radiation use efficiency (RUE) was calculated as per following formula;

$$RUE\ (g/MJ) = \frac{\text{Total dry matter}\ (gm^{-2})}{\text{Cumulative APAR}\ \ (MJm^{-2})}$$

Where,
RUE = Radiation use efficiency
APAR = Absorbed photosynthetic active radiation

Results and Discussions

Accumulated thermal unit

Higher Accumulated thermal unit (GDD) from sowing to maturity 2172°C days was recorded under growing environment of Nov. 5th with temperature 23.8°C mainly due to fulfillment of required thermal unit in longer duration and minimum was recorded under growing environment Nov 25th with temperature 16.8°C due to occurrence of less duration. Among the cultivars maximum Accumulated thermal unit from sowing to maturity 2143°C days was obtained in Uday mainly due to fact that they have taken maximum days for maturity which resulted in more Accumulated thermal unit followed by Pusa-362 (2050.2°C days) while minimum

GDD was obtained in Radhey cultivar (1970.9°C days) from sowing to maturity of chickpea. Similar results were also reported by Saini and Paroda (1990), Singh *et al.*, (2009), Khatun *et al.*, (2010) and Tripathi *et al.*, (2009).

Radiation use efficiency

Higher radiation use efficiency (1.58 g MJ^{-1}) was recorded under Growing environment of Nov. 5th with temperature 23.8°C during all the stages due to accumulation of proportionally higher biomass (dry matter accumulation) per unit of cumulative observed photosynthetically active radiation and minimum radiation use efficiency (1.47 g MJ^{-1}) was recorded under growing environment of Nov. 25th with temperature 16.8 with temperature 20.8°C. Among the cultivars higher radiation use efficiency (1.58 g MJ^{-1}) was recorded under Uday due to accumulation of proportionally higher biomass (dry matter accumulation) per unit of cumulative observed photo synthetically active radiation. Minimum RUE (1.30 g MJ^{-1}) was recorded in Radhey cultivars. Similar results were also reported by Agrawal *et al.*, (2002) (Table 1 and 2).

Table.1 Accumulated thermal unit at different phenophases of chickpea cultivars as affected by growing environments

Treatments	Accumulated (GDD ^{0}C days)					
	Emergence	**Vegetative**	**50% flowering**	**Pod initiation**	**Pod filling**	**Pod maturity**
Growing environments						
Nov 5/23.8^{0}C (D_1)	136	1313	1583	1690	1818	2172
Nov 15/20.8^{0}C (D_2)	132	1276	1535	1643	1780	2081
Nov 25/16.8^{0}C (D_3)	124	1192	1453	1571	1674	2012
Cultivars						
Uday (D_1)	136	1301	1568	1671	1797	2143
Pusa-362 (D_2)	132	1259	1517	1627	1742	2050
Radhey (D_3)	124	1227	1492	1611	1736	1970

Table.2 Radiation use efficiency of chickpea cultivars as affected by growing environment

Treatments	RUE (g/MJ^{-1})						
	30 DAS	**45 DAS**	**60 DAS**	**75 DAS**	**90 DAS**	**105 DAS**	**120 DAS**
Growing environments							
Nov 5/23.8^{0}C (D_1)	0.97	1.17	1.19	1.34	1.63	1.58	1.46
Nov 15/20.8^{0}C (D_2)	096	1.14	1.14	1.30	1.53	1.56	1.15
Nov 25/16.8^{0}C (D_3)	0.86	1.12	1.06	1.20	1.46	1.47	1.37
Cultivars							
Uday (D_1)	0.97	1.17	1.27	1.32	1.63	1.58	1.32
Pusa-362 (D_2)	0.96	1.09	1.26	1.23	1.27	1.47	1.34
Radhey (D_3)	0.94	1.12	1.22	1.22	1.24	1.30	1.28

In conclusion, higher accumulated thermal unit and radiation use efficiency were recorded under growing environment of November 5th with temperature 23.8°C at 105 DAS. Maximum accumulated thermal unit and radiation use efficiency were recorded under Uday cultivars at 105 DAS.

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