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Heat Unit Required in Relation to Phenology of Chickpea Cultivars as Influenced by Sowing Time and Seed Rate

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A B S T R A C T

Field experiments was conducted during *rabi* 2012-13 at Pulse Research Area of CCS Haryana Agricultural University, Hisar to study the heat unit required in relation to phenology of chickpea cultivars as influenced by sowing time and seed rate. The experiment was laid out in a split plot design with two sowing time (1st fortnight of November and 1st fortnight of December) and four cultivars (H09-23, H08-18, C-235 and HC-1) kept in main plots while three seed rates *viz*. 40 kg ha^{-1}, 50 kg ha^{-1} and 60 kg ha^{-1} were kept in subplots and replicated thrice. In the present investigation, important variabilities in terms of growing degree days and helio thermal unit were observed. The results indicated that November sowing resulted in higher value of growing degree days and heliothermal unit to attain all the phenophases except at maturity where the values were higher in December sown chickpea as compared to November sown. Chickpea cultivar HC 1 required highest GDD to achieve seedling emergence, 50% flowering and podding whereas cultivar H09-23 required lowest value. Cultivar H09-23 produced highest grain yield when sown in 1st fortnight of November (2,314 kg ha^{-1}). Delay in sowing time significantly reduced the grain yield of C235. In case of 1st fortnight of December sowing, cultivar HC-1 (1740 kg ha^{1}) performed better in terms of grain yield followed by H09-23 (1,675 kg ha^{-1}). With all the cultivars, delay in sowing reduced the stover yield and it was significantly reduced with 1st fortnight of December sowing of all the cultivars. Cultivar H08-18 produced significantly higher stover yield than the other cultivars at 1st fortnight of December sown chickpea.

Introduction

Vegetative growth of chickpea is particularly sensitive to low temperature because of its being closely related to photosynthesis. The most important factors affecting chickpea productivity are temperature and photoperiod (Summerfield *et al.*, 1980). Temperature based Growing Degree Days and Heat Use Efficiency is quite useful in predicting growth and yield of chickpea. Utilization of heat in terms of dry matter accumulation is also an important aspect. Efficiency of conversion of heat energy into dry matter depends upon genetic factors, sowing time and type of crop (Rao *et al.*, 1999). Temperature is an important environmental factor influencing the growth and development of crop plants. Phenology is an essential component of the crop growth model, which can be used to specify the most appropriate rate and time of specific development process. Increasing appreciation has been shown in recent years for predicting crop development under field condition. The duration of each growth phase determines the accumulation and partitioning of dry matter into different organs as well as crop response to environmental and external factors. The duration of particular stage of growth is directly related to temperature and this duration for particular species could be predicted using the sum of daily air temperature. Influence of temperature on phenology and yield of crop plants can be studied under field condition through accumulated heat units system. Plants have a definite temperature requirement before they attain certain phenological stages. Despite its economic and nutritive importance, the yield of chickpea is very low in India. There are many factors responsible for the low yield *viz*. use of traditional or low yielding varieties, adoption of poor management practices, sowing methods and proper seed rate (Reddy *et al.,* 2003).Various genotypes behave differently due to their plant architecture particularly under late sown condition. Under such situation plant population play an important role in improving the productivity of crop. Time of sowing is an important non-monetary input which has been recognized as the most critical factor in influencing the yield of chickpea.

Materials and Methods

The study was conducted at Pulse Research Area of CCS Haryana Agricultural University, Hisar during *rabi* season of 2012-13 on sandy loam soils under irrigated conditions. The experiment consisting of 24 treatment combinations with two sowing time (1^{st} fortnight of November and 1^{st} fortnight of December) and four cultivars (H09-23, H08-18, C-235 and HC-1) kept in main plots while three seed rates *viz*. 40, 50 and 60 kg ha^{-1} in split plot design with three replications. The soil of the experimental site was deep sandy loam having pH of 7.9, EC of 0.13 dS/m and low in organic carbon (0.34%), low in available N status (193.36 kg ha^{-1}), medium in available P_2O_5 (32.18 kg ha^{-1}) and high in available K_2O (249.67 kg ha^{-1}). The crop was sown with a row spacing of 30 cm as per the dates of sowings after pre sowing irrigation. Recommended dose of fertilizer i.e. 20 N + 40 P_2O_5 Kg ha^{-1} was applied in the form of diammonium phosphate as basal dose at the time of sowing. The crop was irrigated as and when required so as to maintain adequate soil moisture in the root zone. Growing degree days (GDD) were computed by taking a base temperature of 5^0 C. The total sum of degree days for each phenophase was obtained by using the following formula:

Accumulated GDD= $\sum$ [(T max + T min)/2] - Tb

Where,

T max: Daily maximum temperature (^oC)
T min: Daily minimum temperature (^oC)
Tb: Base temperature (^oC)

Accumulated helio-thermal units = Accumulated GDD X mean sun shine hours

Results and Discussion

Accumulated growing degree days (GDD) by chickpea genotypes under different date of sowing and seed rate are presented in Table 1. Sowing on November was found to be most suitable in harnessing the prevailing weather conditions in the region. Different chickpea cultivars responded differently in terms of accumulated GDD to achieve different phenophases. Highest accumulated growing degree day and heliothermal unit were observed under November sowing as compared to December sowing to attain seedling emergence, 50% flowering and podding. It may be due to rise in temperature during reproductive period of the crop. These results are in conformity with the findings of Singh *et. al.* (2008) Different genotypes differ significantly in respect of GDD and HTU attaining different phenophases. Chickpea cultivar HC 1 required highest GDD to achieve seedling emergence, 50% flowering and podding whereas cultivar H09-23 required lowest value. A perusal of data presented in Table 2 indicates the significant interaction between sowing date and cultivars on the grain yield. Cultivar H09-23 produced highest grain yield when sown in 1st fortnight of November (2,314 kg ha^{-1}). However, the difference of grain yield between the cultivars H09-23 and H08-18 were statistically at par. Delay in sowing time significantly reduced the grain yield of C235. In case of 1st fortnight of December sowing, cultivar HC-1 (1740 kg ha^{1}) performed better in terms of grain yield followed by H09-23 (1,675 kg ha^{-1}). Bahal (1984) and Fazlulkabir *et al.*, (2009) also reported that sowing time and genotype interactions significantly influenced the yield attributes and yield of chickpea.

With all the cultivars, delay in sowing reduced the stover yield and it was significantly reduced with 1st fortnight of December sowing of all the cultivars. Maximum stover yield was recorded with cultivar HC-1 at 1st fortnight of November sowing (9977 kg ha^{-1}) and minimum being with the same variety at 1st fortnight of December sowing (4699 kg ha^{-1}). Cultivar H08-18 produced significantly higher stover yield than the other cultivars at 1st fortnight of December sown chickpea (Table 3).

Table.1 Accumulated growing degree days (GDD) and helio thermal unit at different phenological stages of chickpea varieties under different sowing dates and seed rate

Treatments	Phenological stages (DAS)							
	Seedling Emergence		**50% Flowering**		**50% Podding**		**At maturity**	
Date of sowing	**GDD**	**HTU**	**GDD**	**HTU**	**GDD**	**HTU**	**GDD**	**HTU**
1st fortnight of ovember	317.46	2091.57	1920.45	11946.94	2266.90	24240.50	2993.16	20408.55
1st fortnight of December	275.01	1506.16	1455.82	8425.04	2109.91	14443.31	3247.71	23874.26
CD at 5%	19.35	142.65	49.57	376.13	130.03	306.39	100.42	770.88
Cultivars								
H08-18	296.63	1805.72	1690.96	10153.01	2182.54	19129.24	3225.01	22986.57
H09-23	275.50	1644.13	1615.13	9621.57	2016.63	17645.82	3009.73	21295.61
C235	290.72	1756.22	1691.43	10307.61	2178.98	19927.28	3154.01	22352.97
HC-1	322.10	1989.37	1755.02	10661.76	2375.47	20665.27	3092.98	21930.48
CD at 5%	27.37	201.74	70.10	531.92	183.89	433.30	142.01	1090.19
Seed Rate								
40 kg ha^{-1}	297.14	1814.50	1663.84	9984.59	2143.59	19449.87	3125.56	22184.87
50 kg ha^{-1}	292.72	1770.68	1686.89	10193.63	2209.15	19176.28	3140.89	22288.87
60 kg ha^{-1}	298.85	1811.43	1713.69	10379.74	2212.48	19299.55	3094.85	21951.25
CD at 5%	NS	NS	NS	NS	NS	161.81	39.64	277.48

Table.2 Interaction effect of sowing time and cultivars on grain yield of chickpea (kg ha^{-1})

Date of sowing	Cultivars				
	H08-18	**H09-23**	**C235**	**HC-1**	**Mean**
1st fortnight of November	2,270	2,314	1,737	1,928	2,062
1st fortnight of December	1,593	1,675	1,257	1,740	1,566
Mean	1,932	1,995	1,497	1,834	
SEm ± (D) = 36 **CD at 5% (D) = 109**	**SEm ± (V) = 51** **CD at 5% (V) = 154**		**SEm ± (DxV) = 72** **CD at 5% (DxV) = 218**		

Table.3 Interaction effect of sowing time and cultivars on stover yield of chickpea (kg ha^{-1})

Date of sowing	Cultivars				
	H08-18	H09-23	C235	HC-1	Mean
1st fortnight of November	8,507	8,229	9,077	9,977	8,948
1st fortnight of December	6,887	6,180	6,018	4,699	5,946
Mean	7,697	7,205	7,548	7,338	
SEm ± (D) = 296 (DxV) = 592 CD (D) at 5% = 898 (DxV) = 1796	SEm ± (V) = 419 CD at 5% (V) = NS		SEm ± CD at 5%		

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