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

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Abstract

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 heliothermal 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 (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, 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$_2$O$_5$ (32.18 kg ha$^{-1}$) and high in available K$_2$O (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$_2$O$_5$ 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= Σ [(T max + T min)/2] - Tb

Where,

T max: Daily maximum temperature ($^0$C)
T min: Daily minimum temperature ($^0$C)
Tb: Base temperature ($^0$C)

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 heliothermal 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 November | 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 | 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 |
|--------------------------------|-----------|--------|--------|------|------|------|
| 1<sup>st</sup> fortnight of November |           | 2,270  | 2,314  | 1,737 | 1,928 | 2,062 |
| 1<sup>st</sup> 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                   | SEm ± (V) = 51 |      |        |      |      |      |
| CD at 5% (D) = 109               | CD at 5% (V) = 154 |      |        |      |      |      |
| SEm ± (DxV) = 72                | SEm ± (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 |
|--------------------------------|-----------|--------|--------|------|------|------|
| 1<sup>st</sup> fortnight of November |           | 8,507  | 8,229  | 9,077 | 9,977 | 8,948 |
| 1<sup>st</sup> 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                  | SEm ± (V) = 419 |      |        |      |      |      |
| (DxV) = 592                     | CD at 5% (V) = NS |      |        |      |      |      |
| CD (D) at 5% = 898               | CD at 5% (DxV) = 1796 |      |        |      |      |      |

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