Quantification of heat units for chickpea under coastal environment of Andhra Pradesh

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Chickpea (Cicerarietinum) commonly known as gram and Bengal gram is grown in India as winter season (rabi) crop and it requires cool and dry weather for optimum growth. Chickpea being a crop of low input requirement replaced the rice cultivation in some coastal tracts of Andhra Pradesh. The concept of thermal use efficiency has been used by several workers to compare the performance of different varieties or of several dates done elsewhere (Rajput et al., 1987; Rao et al., 1999; Aggarwal et al., 1999) but, it has not hitherto been reported from Andhra Pradesh.

A field experiment was conducted at Agricultural College Farm, Bapatla (A.P) during rabi season of 2007-08. The soil (0-30 cm) of the experimental site is black clay loam in texture with pH of 7.4. The weather parameters were recorded at the meteorological unit. The experiment was laid out in split plot design with 12 treatment combinations comprising of four sowing dates (November 8th, November 18th, November 28th and December 8th) and three cultivars (KAK-2, JG-11 and Annegiri) with three replications. A uniform dose of 20 kg N + 50 kg P_2O_5 was supplied as basal through urea and single super phosphate.

The growing degree days (GDD), was calculated using base temperature of 5°C (Nuttonson, 1955). Heat use efficiency (HUE), which is a measure of amount of dry matter or grain yield produced per unit of GDD, was worked out as per procedures reported by Sahu et al. (2007).

The results revealed that the crop sown on 18th November took 118 days for KAK-2, 111 days for JG-11 and 112 days for Annegiri from sowing to maturity, and it reduced under both early and delayed sowings. The accumulated growing degree days from sowing to maturity varied from 1979 to 2247 °C d (Table 1) with different dates of sowing, maximum under second date of sowing and minimum under fourth date of sowing. GDD requirement was high for KAK-2 followed by Annegiri and low for JG-11.

The amount of total drymatter produced by the crop was maximum under 18th November sowing (3019 kg ha^(-1)) followed by 8th November and minimum under 8th December sowing (1828 kg ha^(-1)). In both the earlier and later sown crops, the amount of total drymatter produced by the crop decline to an extent of 10.4 percent (8th November) to 39.4 percent (8th December). The amount of total drymatter produced by three varieties were in the order of JG-11 > KAK-2 > Annegiri.

The heat use efficiency was high for second sowing. It was low for November 28th crop upto 45 days after emergence and later 8th December sown crop recorded the lowest value. The heat use efficiency was maximum for 18th November sown crop (1.567), followed by 8th November (1.307) and minimum was with December 8th (0.851). The increase in heat use efficiency was maximum at 45 to 60 days after emergence for November 8th sown crop, 30 to 45 days after emergence for 18th November sown crop, 15 to 30 days after emergence for November 28th and December 8th sown crop. A varietal difference was significant at all stages of crop growth. It was higher in KAK-2 upto 45 days after emergence, JG-11 showed the highest. It was lower in Annegiri at all stages of crop growth (Table -2).

The correlation analysis between yield and phenophase wise heat units revealed that yield of KAK-2 was positively and significantly correlated (r=0.97*) with GDD during podding stage. In JG – 11, yield was negatively significantly correlated (r=-0.99*) with GDD during vegetative stage was observed.
Table 1: Accumulated growing degree days (GDD) during different phenophases seed yield and total dry matter of chickpea under different environments

| Treatments | Emergence | Vegetative | Flowering | Podding | Maturity | Seed yield (kg ha\(^{-1}\)) | Total dry matter (kg ha\(^{-1}\)) |
|------------|-----------|------------|-----------|---------|----------|----------------------------|----------------------------------|
| **Sowing dates** |           |            |           |         |          |                            |                                  |
| November 8\(^{th}\) | 95        | 334        | 575       | 522     | 615      | 674                        | 2459                             |
| November 18\(^{th}\) | 97        | 310        | 564       | 583     | 693      | 846                        | 3178                             |
| November 28\(^{th}\) | 130       | 311        | 512       | 546     | 676      | 617                        | 1747                             |
| December 8\(^{th}\) | 147       | 287        | 521       | 503     | 521      | 39.22                      | 12.24                            |
| Mean       | 117.25    | 310.5      | 543       | 538.5   | 626.25   | 117.57                     | 36.71                            |
| SD\(^{+}\) | 25.51     | 19.19      | 31.14     | 34.49   | 77.74    | 674                        | 2459                             |
| **Cultivars** |           |            |           |         |          |                            |                                  |
| KAK-2      | 134       | 326        | 528       | 593     | 612      | 663                        | 2703                             |
| JG-11      | 109       | 300        | 543       | 494     | 632      | 1194                       | 3019                             |
| Annegiri   | 109       | 305        | 558       | 528     | 634      | 534                        | 2295                             |
| Mean       | 117.33    | 310.33     | 543       | 538.33  | 626.66   | 459                        | 1828                             |
| SD\(^{+}\) | 14.43     | 13.79      | 15.0      | 50.30   | 12.85    | 32.70                      | 11.00                            |

Table 2: Heat use efficiency (kg ha\(^{-1}\)\(0\)C day\(^{-1}\)) of chickpea in terms of biological yield as influenced by dates of sowing and varieties

| Treatments | Days after emergence (DAE) |
|------------|---------------------------|
|            | 15 | 30 | 45 | 60 | 75 | 90 | At maturity |
| **Sowing dates** |         |     |     |     |    |    |             |
| November 8\(^{th}\) | 0.352 | 0.684 | 0.781 | 1.202 | 1.267 | 1.307 | 1.248 |
| November 18\(^{th}\) | 0.449 | 0.700 | 1.117 | 1.452 | 1.412 | 1.567 | 1.356 |
| November 28\(^{th}\) | 0.297 | 0.648 | 0.774 | 0.902 | 0.914 | 0.898 | 1.043 |
| December 8\(^{th}\) | 0.348 | 0.686 | 0.792 | 0.849 | 0.851 | 0.830 | 0.916 |
| SEm\(^{+}\) | 0.004 | 0.005 | 0.011 | 0.046 | 0.004 | 0.029 | 0.006 |
| CD | 0.015 | 0.017 | 0.039 | 0.160 | 0.013 | 0.101 | 0.019 |
| CV(%) | 2.51 | 1.52 | 2.74 | 8.93 | 0.70 | 5.38 | 1.04 |
| **Cultivars** |         |     |     |     |    |    |             |
| KAK-2 | 0.488 | 0.823 | 1.114 | 1.173 | 1.165 | 1.200 | 1.117 |
| JG-11 | 0.353 | 0.664 | 0.798 | 1.328 | 1.370 | 1.395 | 1.503 |
| Annegiri | 0.244 | 0.552 | 0.686 | 0.804 | 0.798 | 0.856 | 0.803 |
| SEm\(^{+}\) | 0.011 | 0.008 | 0.016 | 0.036 | 0.004 | 0.027 | 0.006 |
| CD | 0.034 | 0.023 | 0.048 | 0.109 | 0.012 | 0.081 | 0.019 |
| CV(%) | 7.704 | 2.77 | 4.50 | 8.07 | 0.87 | 5.74 | 1.32 |
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*Received : September 2011 ; Accepted : May 2012*