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GROWTH RATE OF CHICKPEA (*CICER ARIETINUM* L.) GENOTYPES UNDER DIFFERENT PLANTING DATES

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SUMMARY

High temperature is one of the important abiotic stresses limiting chickpea productivity. A field experiment was, therefore, conducted to study the effect of temperature on crop growth rate in six chickpea genotypes, viz., Pusa 256, Pusa 372, BGD 72 (released varieties) and DG 36, DG 46 and DG 51 (advance lines) grown under different planting dates. DG 36 showed higher leaf area index (LAI), crop growth rate (CGR) expressed on per day and per growing degree days (GDD), compared to other genotypes. Pusa 372 showed the lowest values of these traits. The minimum requirement of GDD was recorded in the genotype DG 36. In general, the advance lines under study required less accumulated heat units as compared to the released varieties.

Key words: **Accumulated heat units, chickpea, crop growth rate, GDD, leaf area index**

INTRODUCTION

Chickpea (*Cicer arietinum* L.) is the third most important pulse crop of the world after dry bean and dry pea and widely cultivated in west and south Asia and north African countries. Pulses are inseparable ingredients of vegetarian diets and one of the cheapest source of dietary protein in Indian subcontinent. India, in spite, of being the largest producer in the world, imports pulses to the tune of 2 million tonnes every year to meet the domestic requirements. India contributes 67% of the global chickpea production. The major constraints of low productivity are abiotic stresses like moisture, temperature, nutrients and salinity. Among them high temperature stress particularly at terminal stage of crop growth is the most important abiotic stress for chickpea productivity. This is because, the planting of chickpea is delayed due to late harvest of major kharif crops like rice, sugarcane and potato. Additionally, drought is also an important constraint for chickpea cultivation. Under resource constraints, rice-chickpea is the more remunerative than rice-wheat cropping system in north western parts of India as it requires less inputs than rice-wheat. Market price of chickpea is about four times higher than the wheat and also maintains the fertility of soil by fixing atmospheric N_2 through root nodules. Survival capacity of chickpea is also very high in comparison to wheat in rainfed condition due to long and deep root system. Under these circumstances continuous growing of wheat has shown disadvantages, viz. depletion of water table due to more requirement of irrigations and nutrients. It is, therefore, considered that chickpea is better substitute in *rabi* season in north western plains. Strand (1987) reported that early sowing in wheat increased the heat sum requirement by the cultivars because of longer duration. Bisnoi and Taneja (1990) showed that with the increase of average temperature in the crop season, phenological stages are advanced rapidly due to availability of higher thermal units over a short period of time. This may result in forced

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maturity. One, thus, needs a variety, which takes less GDD for physiological maturity. Ghadekar *et al*. (1992) reported that early sowing resulted in highest accumulation of heat sum and photothermal units causing better growth and yield. Therefore, it was aimed to study the relative variation in leaf area development, crop growth rate of chickpea in advance breeding lines and in released varieties under different planting dates.

MATERIALS AND METHODS

A field experiment was conducted at research farm of the Indian Agricultural Research Institute, New Delhi during 2002-03. The experiment was laid out in split plot design with time of planting (main plot) and genotypes as (sub plots). Three released varieties, viz. Pusa 256, Pusa 372, BGD 72 and three advance lines, viz. DG 36, DG 46, DG 51 were grown under three dates of planting, i.e. 15 November, 30 November and 15 December 2002. Plants were grown at a distance of 30 cm between rows and 10 cm within a row. The plant samples were collected for the study of leaf area index at 30, 60, 90 and 105 days after sowing (DAS) and for crop growth rate between 30-60 DAS, 60-90 DAS and 90-105 DAS. The leaf area m^{-2} land area was measured by leaf area meter (LI 3100, USA). The growing degree days (GDD) was calculated by the summation of mean temperature above a base value.

$$\text{GDD} = \Sigma \frac{T_{max} + T_{min}}{2} - \text{Tb degree days}$$

Where, T_{max} and T_{min} are the maximum and minimum temperatures, respectively. Tb is the base temperature for chickpea, which is 5^0C (Rao *et al*. 1999). Calculation of plant growth rate was done on per day and GDD basis for the period 30-60 DAS, 60-90 DAS and 90-105 DAS. The data were statistically analysed by the procedure given by Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

Leaf area index (LAI)

Pusa 372 recorded lowest leaf area index (LAI), while DG 36 showed the highest at all the growth stages and planting dates. Advance lines recorded maximum LAI in comparison to released genotypes. A perusal of data (Table 1) revealed that LAI increased with the advancement of the crop age. Significant differences were recorded in first planting, second and third planting at 30 days after sowing (DAS), Haloi and Baldev (1986) observed that LAI was influenced by the date of planting. A significantly higher LAI was recorded in DG 36 (0.105) followed by DG 46 (0.097), BGD 72 (0.091) and Pusa 256 (0.084) in comparison to Pusa 372, at 30 DAS. At 60 DAS also, significant differences were observed among all the six genotypes studied. Significantly higher LAI was recorded at 90 DAS in second planting (1.424) followed by third (1.342) and first planting (1.231). Among the genotypes, all the advance lines and BGD 72 showed significantly higher LAI as compared to Pusa 256 (1.112). Significantly higher LAI was exhibited at 105 DAS, in second planting (1.558) followed by first planting (1.506) and third planting (0.964). Among all the genotypes significantly higher leaf area index was noticed in DG 36 (1.693), DG 46 (1.469), DG 51 (1.464), Pusa 256 (1.192) and BGD 72 (1.127) as compared to Pusa 372 (1.084). The genotypic differences, which expressed more clearly under various planting conditions in the present study are in the line with the observations reported by Hsiao (1973), Boyer (1982), Uprety and Sirohi (1987), Aggarwal and Koundal (1988) and Rahangdale *et al.* (1994).

Crop growth rate (CGR)

Significant differences in CGR values were recorded between 30-60 DAS in all the three dates of planting. Highest CGR was recorded in the first planting (1.56), intermediate in second (1.11) and least in the third planting (0.67). Renu Khanna Chopra and Sinha (1987) also emphasized importance of high CGR for attaining high productivity in chickpea. As far as the genotypes are concerned significantly higher CGR was recorded in DG 36 and least in Pusa 372 (Table 2). Between 60-90 DAS, significantly higher CGR was recorded in second and third planting as 4.68 and 4.85, respectively, than first planting (2.39). Among the genotypes all the advance lines exhibited significantly higher CGR as compared to Pusa 256. With regards to genotypes, during 90-105 DAS, significantly higher CGR was recorded in

Table 1. Leaf area index (LAI) of chickpea genotypes as influenced by date of planting.

Genotype	Time of planting			Mean
	Nov. 15	Nov. 30	Dec. 15	
	30 DAS			
Pusa 256	0.141	0.087	0.024	0.084
Pusa 372	0.130	0.066	0.020	0.072
BGD 72	0.152	0.087	0.034	0.091
DG 36	0.180	0.102	0.034	0.105
DG 46	0.158	0.106	0.026	0.097
DG 51	0.122	0.089	0.024	0.078
Mean	0.147	0.089	0.063	-
	Planting time (P)	Genotype (G)	PxG	
C.D. at 5%	0.004	0.004	0.007	
	60 DAS			
Pusa 256	0.366	0.311	0.266	0.314
Pusa 372	0.325	0.292	0.262	0.293
BGD 72	0.393	0.331	0.280	0.335
DG 36	0.465	0.422	0.412	0.433
DG 46	0.424	0.404	0.333	0.387
DG 51	0.402	0.387	0.305	0.365
Mean	0.396	0.358	0.310	-
	Planting time (P)	Genotype (G)	PxG	
C.D. at 5%	0.012	0.011	0.019	
	90 DAS			
Pusa 256	1.065	1.212	1.060	1.112
Pusa 372	1.034	1.185	1.127	1.115
BGD 72	1.124	1.230	1.136	1.163
DG 36	1.487	1.852	1.631	1.657
DG 46	1.375	1.654	1.576	1.535
DG 51	1.299	1.413	1.520	1.411
Mean	1.231	1.424	1.342	-
	Planting time (P)	Genotype (G)	PxG	
C.D. at 5%	0.051	0.049	0.085	
	105 DAS			
Pusa 256	1.371	1.401	0.804	1.192
Pusa 372	1.196	1.335	0.722	1.084
BGD 72	1.272	1.316	0.794	1.127
DG 36	1.931	1.961	1.186	1.693
DG 46	1.641	1.686	1.160	1.496
DG 51	1.627	1.648	1.116	1.464
Mean	1.506	1.558	0.964	-
	Planting time (P)	Genotype (G)	PxG	
C.D. at 5%	0.047	0.043	0.074	

Table 2. Crop growth rate (g m^{-2} day^{-1}) of chickpea genotypes as influenced by date of planting.

Genotype	Time of planting			Mean
	Nov. 15	Nov. 30	Dec. 15	
	30-60 DAS			
Pusa 256	1.75	1.35	0.77	1.29
Pusa 372	1.26	0.92	0.42	0.87
BGD 72	1.63	0.92	0.62	1.06
DG 36	1.97	1.24	1.03	1.41
DG 46	1.33	1.07	0.57	0.99
DG 51	1.40	1.13	0.58	1.04
Mean	1.56	1.11	0.67	-
	Planting time (P)	Genotypes (G)	PxG	
C.D. at 5%	0.041	0.043	0.075	
	60-90 DAS			
Pusa 256	1.99	3.91	3.66	3.19
Pusa 372	2.57	3.99	3.93	3.50
BGD 72	1.61	4.60	3.82	3.34
DG 36	2.27	5.14	6.32	4.58
DG 46	3.41	5.44	5.76	4.87
DG 51	2.51	5.00	5.62	4.38
Mean	2.39	4.68	4.85	-
	Planting time (P)	Genotypes (G)	PxG	
C.D. at 5%	0.181	0.190	0.329	
	90-105 DAS			
Pusa 256	4.50	5.39	2.75	4.21
Pusa 372	2.34	4.30	3.84	3.49
BGD 72	5.44	5.12	5.59	5.38
DG 36	7.96	6.34	3.79	6.03
DG 46	5.89	3.98	3.11	4.33
DG 51	5.88	4.47	3.39	4.58
Mean	5.34	4.93	3.75	-
	Planting time (P)	Genotypes (G)	PxG	
C.D. at 5%	0.211	0.176	0.306	

DG 36 (6.03) followed by BGD 72 (5.38), DG 51 (4.58), DG 46 (4.33), Pusa 256 (4.21) and least in Pusa 372 (3.49).

In general, advance breeding lines retained comparatively higher CGR values at successive crop growth stages in comparison to released varieties. Advance breeding line DG 36 showed maximum CGR value between 30-60 DAS (1.41) and 90-105 DAS (6.03). While at 60-90 DAS, DG 46 showed maximum CGR value (4.87). Released variety Pusa 372 recorded minimum CGR between 30-60 DAS (0.87) and between 90-105 DAS (3.49). Between 60-90 DAS, Pusa 256 showed minimum CGR (3.19) value. The positive association between leaf area index and crop growth rate was also reported by Hsiao (1973), Summerfield *et al.* (1979) and Boyer (1982).

Accumulated heat units (GDD)

The accumulated heat units or GDD taken to attain different phenological phases, i.e. 50 per cent flowering, 50 per cent pod formation and maturity of the six genotypes under different planting dates are presented in Fig. 1. In general the growing degree days (GDD) requirement for 50 per cent flowering, 50 per cent pod formation and maturity were higher in first planting followed by second and third planting (Fig. 1). The advance breeding lines required less GDD than the released varieties. The low accumulated heat units were associated with early attainment of phenophases and high yield in different crop plants. Similar observations were also recorded by Strand (1987), Bishnoi and Taneja (1990), Sharma and Sonakiya (1990), Ghadekar *et al.* (1992), Lama *et al*. (2003) and Paikaray and Chakravarty (2003). In the present investigation all the phenophases in the advance lines were attained earlier than the released varieties. This clearly shows that their growth is relatively faster than released varieties.

Crop growth rate per GDD

Growth rate per GDD of six chickpea genotypes as influenced by date of planting presented in Table 3. On the basis of the data recorded, it was observed that growth rate per GDD was significantly higher in 15 November planting (0.201 g) followed by 30 November

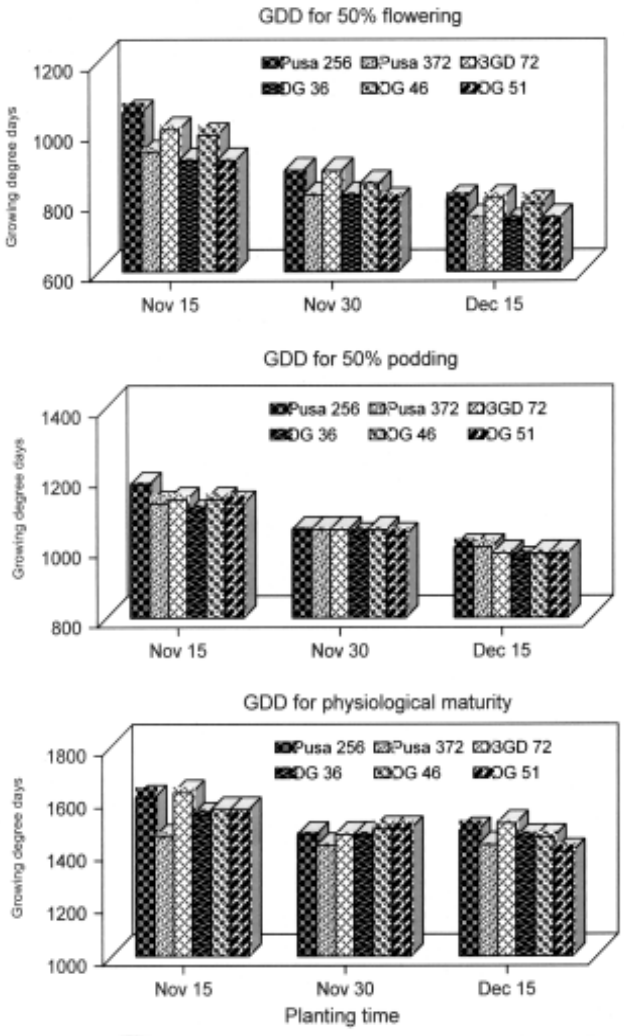

Fig. 1. Growing degree days for different phenophases of chickpea genotypes as influenced by date of planting

planting (0.142 g) and 15 December planting (0.086 g) during 30-60 DAS. Between 60-90 DAS significant differences were recorded between all the three dates of planting, while at during 90-105 DAS significant differences were recorded in 15 November planting (0.372g) followed by 30 November planting (0.344 g) and 15 December planting (0.261g). The higher growth rate per GDD was recorded in early maturing and high yielding genotypes. Similar observations were also recorded by Strand (1987), Bishnoi and Taneja (1990), Sharma and Sonakiya (1990), Ghadekar *et al.* (1992), Lama *et al*. (2003) and Paikaray and Chakravarty (2003) in different crops. With regards to genotypes, Pusa 372 showed significantly lower growth rate per

Table3. Crop growth rate (g/m^2/GDD) of chickpea genotypes as influenced by date of planting.

Genotype	Date of planting			Mean
	Nov. 15	Nov. 30	Dec. 15	
	30 – 60 DAS			
Pusa 256	0.226	0.174	0.099	0.166
Pusa 372	0.162	0.119	0.054	0.112
BGD 72	0.210	0.119	0.080	0.136
DG 36	0.254	0.160	0.133	0.182
DG 46	0.171	0.138	0.073	0.128
DG 51	0.180	0.146	0.075	0.134
Mean	0.201	0.142	0.086	
	Planting time (P)	Genotype (G)	PxG	
C.D. at 5%	0.006	0.005	0.008	
	60 – 90 DAS			
Pusa 256	0.235	0.461	0.432	0.376
Pusa 372	0.303	0.471	0.463	0.412
BGD 72	0.190	0.542	0.450	0.394
DG 36	0.268	0.606	0.745	0.540
DG 46	0.402	0.642	0.679	0.574
DG 51	0.296	0.590	0.663	0.516
Mean	0.282	0.552	0.572	
	Planting time (P)	Genotype (G)	PxG	
C.D. at 5%	0.011	0.010	0.018	
	90 – 105 DAS			
Pusa 256	0.313	0.375	0.192	0.293
Pusa 372	0.163	0.299	0.267	0.243
BGD 72	0.379	0.357	0.389	0.375
DG 36	0.554	0.442	0.264	0.420
DG 46	0.410	0.277	0.217	0.301
DG 51	0.409	0.311	0.236	0.319
Mean	0.372	0.344	0.261	
	Planting time (P)	Genotype (G)	PxG	
C.D. at 5%	0.009	0.008	0.014	

GDD among all the genotypes during 30-60 DAS and 90-105 DAS. Between 60-90 DAS Pusa 256 recorded significantly lower growth rate per GDD among all the genotypes. Advance line DG 36 showed higher growth rate per GDD among all the genotypes at all the planting dates. In general mean values of the growth rate per GDD was significantly higher in advance lines than in released genotypes between 30-60, 60-90 and 90-105 DAS. This clearly indicated that growth rate per GDD of advance lines is faster than released genotypes. It means they are early maturing and high yielding because of better utilization of accumulated heat units.

This study indicated that chickpea genotype DG 36 showed higher LAI, CGR per day and per GDD at all the growth stages and planting dates. However, Pusa 372 showed least values of above three traits. It confirmed that the genotypes which have higher LAI, CGR per day and per GDD are better for increasing the chickpea productivity under stress environment. It means short duration/early maturing genotypes should be developed for such conditions.

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