TECHNOFAME- A Journal of Multidisciplinary Advance Research

Vol.10 No. 2, Page No. 162–166 (2021)
Received: July, 2021; Accepted: October, 2021

Thermal unit Requirements for Different Phenological Stages and Yield of Chickpea Varieties as Influenced by Sowing Dates

P. K. Tyagi, K. C. Shukla and V.K. Singh
Jawaharlal Nehru Krishi Vishwa Vidayalaya
College of Agriculture, Tikamgarh-472 001 (M.P.)
Corresponding author's email: pktyagi197071@yahoo.com

Abstract

Field experiment was conducted to study the effect of sowing dates on thermal unit requirements, yield and its components in chickpea varieties under different growing environments during consecutive two years in rabi 2019-20 and 2020-21 at JNKVV, College of Agriculture, Tikamgarh (Madhya Pradesh). Results revealed that duration of growth stages and accumulated thermal units during sowing to maturity decreased with successive delay in sowing. November 05 sown crop took the maximum days and accumulated thermal units to attain maturity followed by November 25 and December 15 sowings. Subsequent 20 days delayed sowing from November 5 to November 25 and December 15 resulted into decreased in total accumulated thermal units to attain maturity by 10.8% and 19.8%, respectively. Similarly, yield attributing characters viz., number of pods (plant^{-1}), 100-seed weight (g), seed yield (kg ha^{-1}), biological yield (kg ha^{-1}), straw yield (kg ha^{-1}) and harvest index were also found significantly higher in November 5 sown crop as compared to November 25 and December 15 sown crops. Subsequent 20 days delayed sowing from November 5 to November 25 and December 15 resulted into decreased in seed yield by 23.1% and 38.4%, respectively. Among varieties, JG-12 took significantly maximum days to attain maturity with higher total accumulated thermal units followed by JG-36, JG-315, RVG 201 and RVG 202. Chickpea var. JG-12 also exhibited significantly more number of pods (plant^{-1}), number of seeds pod^{-1}, seed yield (kg ha^{-1}), biological yield (kg ha^{-1}), straw yield (kg ha^{-1}) and harvest index followed by JG-36, JG-315, RVG 201 and RVG 202. However, 100-seed weight was found significantly greater in RVG 202.

Key words: *Thermal unit, chickpea, sowing dates, varieties, yield.*

Introduction

Chickpea (*Cicer arietinum* L.) is a premier pulse crop of India grown in *rabi* season under various cropping systems as rainfed crop and raised mainly on conserved soil moisture. It requires cool and dry weather for optimum growth and development. Optimum sowing time and selection of improved varieties play a significant role in exploiting the yield potential of the crop under particular agro-climatic conditions[5]. Different planting dates subject the vegetative and reproductive stages of the plant to various temperature, solar radiation and day length[5]. Sowing date has been proved to be one of the most non-monetary inputs affecting the yield of the crop. The exposure of crop to low temperatures during germination and seedling establishment and to high temperature during flowering and seed formation phases under delay-sown chickpea results in drastic reduction in yield. the optimum sowing time is important to exploit the environmental conditions during the growth of chickpea for maximum production. Delayed sowing causes early maturity resulted in drastic reduction in yield and can vary 30% to 60% depending on genotype, sowing time, location and climatic conditions during sowing season. The productivity of chickpea fluctuate as it responds differently due to their variations in the thermal requirements of given cultivars in a particular climatic conditions[6]. The chickpea genotypes differ in their yielding ability under different growing environment, thus calls for a need to generate more information on the response of chickpea genotypes to the dates of sowing for greater yields in a given agro-climatic conditions. Hence, keeping in view of above facts, present investigation was under taken.

Materials and Methods

Field experiment was conducted at Agronomy Research Area, J.N.K.V.V., College of Agriculture, Tikamgarh Madhya Pradesh (24° 43' N latitude and 78° 49' E longitude at an altitude of 358m above mean sea level), during two consecutive seasons of *rabi* 2019-20 and 2020-21. The experimental site is of sub-tropical climate characterized by hot dry summers and cool dry winter lies in the Bundelkhand Zone (Agro-climatic Zone-VIII). The soil of experimental field was medium to deep black and clayey loam in texture having pH 7.1, EC 0.12 dS m^{-1}, organic carbon 0.5%, available N 266 kg ha^{-1}, available P_2O_5 26 kg ha^{-1} and available K_2O 255 kg ha^{-1}. The average annual rainfall of this region is about 1000 mm, which is mostly received between June to September and a little rainfall of 90 mm is also obtained during October to May. The average temperature ranges between 4.5 °C to 45 °C. The experiment was conducted in split-plot design with three replications and comprised of three sowing dates *viz*., November 5, November 25 and December 15 as main plot treatments and five cultivars *viz* ., JG-12, JG-36, JG-315, RVG 201 and RVG 202 as sub-plot treatments. The full recommended doses of nitrogen (20 Kg N ha^{-1}), phosphorus (40 Kg P_2O_5 ha^{-1}) and potassium (20 kg k_2O ha^{-1}) were applied at sowing. The chickpea crop was sown in lines 30 cm apart using a seed rate of 80 kg ha^{-1}. All other agronomic and plant protection measures were applied as per recommendations. Yield attributes were recorded from the five plants sample collected at the time of harvest. The crop harvested from net plot area was threshed after 4-5 days of sun drying and the seed yield of net plot was then converted into kg ha^{-1}. Before threshing of the crop harvested from net plot, the sun dried whole plant samples were weighed and then converted into kg ha^{-1} to obtain biological yield. Straw yield is obtained by subtracting seed yield (kg ha^{-1}) from biological yield (kg ha^{-1}). The accumulated thermal units (°C) at various growth stages were determined by summing the daily mean temperatures above the base temperature (T_b=5°C)[3]. The results of both the years were more or less similar and hence two years data were pooled and analyzed statistically to draw suitable inference.

Results and Discussion

Phenological stages and thermal units

Duration and accumulated thermal unit of different phenological stages during the entire growth period of chickpea varieties decreased with each 20 days successive delay in sowing from November 5 to November 25 and December 15 (Table 1). The November 5 sown chickpea crop took longer duration for maturity (121 days) than the later sown crop in due to fulfillment of thermal unit requirements in more days and also due to due to increased reproductive phase duration. The total accumulated thermal units during the entire growth period of the crop decreased from 1468 °C under November 5 sowing to 1310 °C and 1178 °C under late sowings on November 25 and December 15, respectively. November 5 sown crop accumulated higher thermal units for all the growth stages followed by November 25 and December 15 sowings. Twenty-day successive delay in sowing from November 5 to November 25 and December 15 reduced the crop duration by 6 and 13 days, respectively and accumulated thermal units by 158 and 290°C, respectively. These findings are in confirmation with results of other workers[2,3,4]. Among cultivars, JG-12 had higher thermal unit requirement due to comparatively longer duration of maturity followed by *cvs*. JG-36, JG-315, RVG 201 and RVG 202. The varietal differences in chickpea for phasic duration and thermal units were also reported by other workers[4].

Table 1 Days taken to attain different phenological stages and accumulated thermal units in chickpea varieties as affected by various treatments (Pooled over two years)

Treatments	Emergence	First flowwr	First pod	Maturity	Vegetative phase	Reproductive phase
Sowing dates						
November 5	5 (116)	53 (770)	65 (989)	121 (1468)	53 (770)	68 (698)
November 25	6 (92)	57 (690)	70 (850)	115 (1310)	57 (690)	58 (620)
December 15	7 (90)	61 (592)	75 (772)	108 (1178)	61 (592)	47 (586)
S.Em±	**0.23**	**0.51**	**0.37**	**0.56**	**0.51**	**0.71**
CD at 5%	**0.69**	**1.51**	**1.15**	**1.69**	**1.51**	**2.15**
Varieties						
JG-12	5 (96)	54 (676)	64 (861)	117 (1332)	54 (676)	63 (656)
JG-36	5 (96)	54 (677)	64 (865)	116 (1330)	54 (677)	62 (653)
JG-315	5 (97)	55 (680)	66 (869)	116 (1318)	55 (680)	61 (638)
RVG 201	7 (101)	59 (686)	76 (875)	112 (1311)	59 (686)	53 (625)
RVG 202	7 (103)	62 (690)	78 (880)	113 (1302)	62 (690)	51 (612)
S.Em±	**0.22**	**0.50**	**0.40**	**0.55**	**0.50**	**0.68**
CD at 5 %	**0.65**	**1.47**	**1.21**	**1.62**	**1.47**	**2.01**

Values in parenthesis are accumulated thermal units in °C

Yield attributes and yield

Yield attributes and yield were significantly influenced due to growing environments (Table 2). Crop sown on November 5 resulted into significantly more numbers of pods (29.8 plant^{-1}) and 100-seed weight (18.8 g) followed by November 25 (19.9 plant^{-1} and 17.6 g, respectively) and December 15 (15.2 plant^{-}

1 and 17.0 g, respectively) sown crops. This may be attributed to favourable environmental effect on plant growth and development under Nov. 5 sown crop, which reflected into more number of pods plant^{-1} and 100-seed weight. Variation in sowing time beyond optimum was found to decrease the number of pods plant^{-1}[1]. However, number of seeds pod^{-1} among the different sowing dates did not differ significantly.

Table 2 Chickpea yield and its attributes as affected by various treatments (Pooled over two years)

Treatments	Number of pods (plant^{-1})	Number of seeds (pod^{-1})	100- seed weight (g)	Seed yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Biological yield (kg ha^{-1})	Harvest index (%)
Sowing dates							
November 5	29.8	1.5	18.8	1613	3217	4830	33.4
November 25	19.9	1.5	17.6	1240	2722	3962	31.3
December 15	15.2	1.4	17.0	994	2297	3291	30.2
S.Em±	**0.8**	**0.05**	**0.3**	**52**	**82**	**129**	**0.9**
CD at 5%	**2.3**	**NS**	**0.9**	**155**	**244**	**384**	**2.7**
Varieties							
JG-12	26.4	1.8	15.3	1545	3123	4668	33.1
JG-36	25.6	1.7	15.2	1511	3138	4649	32.5
JG-315	21.3	1.6	15.0	1333	2860	4193	31.8
RVG 201	18.1	1.1	21.3	1055	2416	3472	30.4
RVG 202	16.7	1.1	22.2	995	2290	3285	30.3
S.Em±	**0.6**	**0.05**	**0.3**	**40**	**68**	**99**	**0.7**
CD at 5 %	**1.8**	**0.2**	**1.0**	**121**	**201**	**299**	**2.1**

The significantly higher seed yield (1613 kgha^{-1}), straw yield (3217 kg ha^{-1}), biological yield (4830 kg ha^{-1}) and harvest index (33.4) were also recorded in November 5 sowing followed by November 25 (1240 kgha^{-1}, 2722 kgha^{-1}, 3962 kgha^{-1} and 31.3, respectively) and December 15 (994 kgha^{-1}, 2297 kgha^{-1}, 3291 kgha^{-1} and 30.2, respectively). The higher seed yield produced by November 5 sowing might be attributed to improved yield attributes *i.e.*, number of pods plant^{-1} and 100-seed weight. The favourable effect of November 5 sown crop on sink components could be attributed to better development of the plants in terms of plant height, more branches and dry matter production leading to increased bearing capacity due to optimum growth on account of favourable temperatures during early vegetative phase. The maximum temperature during reproductive phase had negative correlation with number of pods and seed yield. The successive increased in temperature from 22.1 °C (November 5) to 24.8°C (November 25) and 28.9°C (December 15) during first pod to maturity decreased the seed yield by 23.1% and 38.4%, respectively and number of pods by 33.2% and 48.9%, respectively. These results corroborate the findings of other workers[4].

Among varieties, *cvs*. JG-12 and JG-36 being at par produced significantly higher number of pods (26.4 plant^{-1} and 25.6 plant^{-1}, respectively), number of seeds

(1.8 pod^{-1} and 1.7 pod^{-1}, respectively) and 100-seeds weight (15.3g and 15.2g, respectively) as compared to *cvs*. JG-315 (21.3plant^{-1}, 1.6 pod^{-1} and 15.0g, respectively), RVG 201 (18.1plant^{-1}, 1.1 pod^{-1} and 21.3g, respectively) and RVG 202 (16.7plant^{-1}, 1.1 pod^{-1} and 22.2g, respectively). The differences in yield attributing characters among varieties could be attributed to their genetic constitution[5]. Similarly, *cvs*. JG-12 and JG-36 being at par also produced significantly higher seed yield (1545 kg ha^{-1} and 1511 kg ha^{-1}), biological yield (4668 kg ha^{-1} and 4649 kg ha^{-1}) and harvest index (33.1 and 32.5) followed by *cvs*. JG-315 (1333 kgha^{-1}, 4193 kg ha^{-1}and 31.8, respectively), RVG 201 (1055 kg ha^{-1}, 3472 kg ha^{-1} and 30.4, respectively) and RVG 202 (995 kg ha^{-1}, 3285 kg ha^{-1} and 30.3, respectively). However, straw yield was found significantly higher in JG-36 (3138 kgha^{-1}) over rest of the varieties but found at par with variety JG-12.

Cultivars JG-12 recorded 15.9%, 46.6% and 55.3% higher seed yield over JG-315, RVG 201 and RVG 202, respectively. While cultivar JG-36 give rise 13.4%, 43.2% and 51.9% increased seed yield over JG-315, RVG 201 and RVG 202, respectively. The higher seed yield in *cvs*. JG-12 and JG-36 might be due to better sink in terms of more number of pods (plant^{-1}) and more number of seeds pod^{-1}. The significantly lower seed yield (kg ha^{-1}) in *cv*. RVG 201 and RVG 202 might be due to lesser number of pods (plant^{-1}) and lesser number of seeds pod^{-1}.

Conclusion

The present study concluded that sowing of chickpea on November 5 exhibited significantly higher seed yield due to optimal thermal requirements for various plant processes. The thermal unit requirements of chickpea cultivars decreased with delay in sowing beyond November 5. The maximum temperature during reproductive phase had negative correlation with number of pods and seed yield.

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