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Sowing Dates and Varieties Mediated Changes in Growth and Phenology of Chickpea in Norther Telangana Zone

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Present field experiment was conducted during *spring* (November, 2022-May, 2023) at college farm, agricultural college Jagtial, Telangana to find optimum sowing window of chickpea and efficient varieties under different dates of sowing to northern Telangana zone. Chickpea, a cool season crop grown in India during *spring*, growth and phenology of the crop were highly affected by climatic conditions. Hence, optimum weather conditions at all growth stages were required by crop, which could be acquired by timely sowing. Experiment was laid out in split plot design with six dates of sowing (1[st]November to 15[th]January at 15 days interval) in main plots and three varieties

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(JG-14, NBeG-3, NBeG-47) in sub plots replicated thrice. Results revealed that LAI (0.54,1.22,1.23,1.05) and CGR (0.31,1.80,11.05,0.94) of chickpea was highest with crop sown on 1st November at branching, flowering, pod formation and maturity stages respectively and lowest with 15th January sowing (LAI-0.25,0.98,1.05,0.92 and CGR-0.19,1.02,4.76,0.21). While among varieties NBeG-3 performed best with highest LAI and CGR at different stages compared to other varieties. Days to different phenophases i.e., days to branching initiation, first flower initiation, first pod initiation and physiological maturity was maximum with early sowing (1st November) and minimum with late sowing (15th January). Hence, early sown crop experienced favourable weather conditions and took higher number of days to maturity, while late sown crop was matured early due to unfavourable weather conditions declining crop overall biomass.

Keywords: Chickpea; dates of sowing; varieties; LAI; CGR; phenology.

1. INTRODUCTION

Chickpea (*Cicer arietinum* L.) major pulse crop belongs to Leguminosae family, which is third most cultivated legume in arid and semi-arid regions over the globe due to its immense significance in farming systems and diet (Richards et al., 2022). Pulses are the major source of protein in human diet eminently in countries of south Asia, among pulses chickpea is majorly consumed to fulfil protein requirement (Kumar et al., 2022b) which is nutritionally balanced pulse as it contain proteins, carbs, fibre, minerals and vitamins (Kumar et al., 2023, Patil et al., 2024). Along with, it has significant importance in agroecosystem due to its resilience to harsh climatic conditions, enhance soil fertility by nitrogen fixation capacity, component of crop rotation which breaks pest and disease cycles (Kumar et al., 2020). Generally, chickpea is of two types desi and kabuli where, desi type seeds are small and dark coloured. While, kabuli seeds are larger and light coloured. In India desi type are majorly cultivated (Terin et al., 2022). India is the leading producer of chickpea with an area of 9.48 mha, production of 11.03 mt and productivity of 1151 kg ha^{-1} (Anonymous, 2024a). which accounts for about 68% of total area and 66% of total production over globe (Kumar et al., 2022b). It is grown during spring season all over the country due to its several benefits. Major states growing are Madhya Pradesh, Rajasthan, Maharashtra and Karnataka (Kumari and Malik, 2024). In Telangana it is grown in area of 1.48 lakh ha during spring season with production of 2.32 lakh t and productivity is 1568 kg ha^{-1} (Anonymous, 2024b). Majorly in districts of norther Telangana zone. As chickpea is a spring season crop it require cool, dry and sunny weather conditions for optimum growth and development (Niveditha et al., 2022). In India it is grown mostly during spring on residual soil moisture. Growth and yield of crop is limited by several biotic and abiotic stresses. Abiotic stress majorly includes unfavourable climatic conditions during various growth stages. More than 6.4 mt yield loss in chickpea may be expected due to abiotic stress compared to biotic stress which is 4.8 mt (Jha et al., 2016). Biotic stress may arise due to improper selection of sowing date. Sowing date is an important non-monetary input of agriculture which decides the crop growth and yield, it may vary based on the agroclimatic region (Tyagi, 2014). Delay of sowing lead to changes in crop phenology i.e., number of days to attain different phenophases may reduce due to hight temperatures (30-35°C) coinciding with reproductive stages (Bhattacharya, 2022). Pre anthesis and anthesis stages are more sensitive to high temperature (34°C) which negatively affects pod formation (Pipaliya et al., 2020) and lead to seed yield reduction due to flower drop and reduced pollen viability (Vyshnavi et al., 2024). Selection of variety by the farmer to particular conditions is also a major factor influencing the productivity of crop, as each variety have a different yielding potential under varied agroclimatic conditions due their inherent capacity (Yadav et al., 2023) In norther Telangana zone where rice is cultivated as major crop during autumn followed by chickpea in spring season. The date of sowing may vary greatly due to delay of paddy harvest and land preparation. Under such condition date of sowing may be varied and it may not be possible to follow exact date of sowing recommended. In this scenario present investigation was carried to find effect of dates of sowing on plant growth indices and crop phenology which helped in understanding best sowing window for chickpea in northern Telangana zone along with selection of best suitable variety under varied dates of sowing.

2. MATERIALS AND METHODS

2.1 Details of Experimental Location

The experiment was conducted during spring (November, 2022-May, 2023) at college farm Agricultural college, Jagtial, Professor Jaya Shanker Telangana Agricultural University, Telangana, which was shown in Fig. 1. It was geographically located at 18º 50’37.0” N latitude,78º 57’00.6” E longitude and altitude of 243.4 m above mean sea level, which fall under semi-arid tropical climate. The weather conditions during crop period were as average temperature of 25.4 ˚C, average relative humidity (40.6%), bright sunshine h day^{-1}(7.5), wind velocity (4.1 km hr^{-1}) and total evaporation (616 mm). The soil of experimental field was Sandy clay loam in texture and nutrients status was summarized in Table 1.

Table 1. Soil nutrient status

Parameters	pH	EC (dS m^{-1})	BD (Mg m^{-3})	OC (%)	N (kg ha^{-1})	P (kg ha^{-1})	K (kg ha^{-1})	Soil texture
Values	7.8	0.21	1.51	0.5	270	36	416	Sandy clay loam

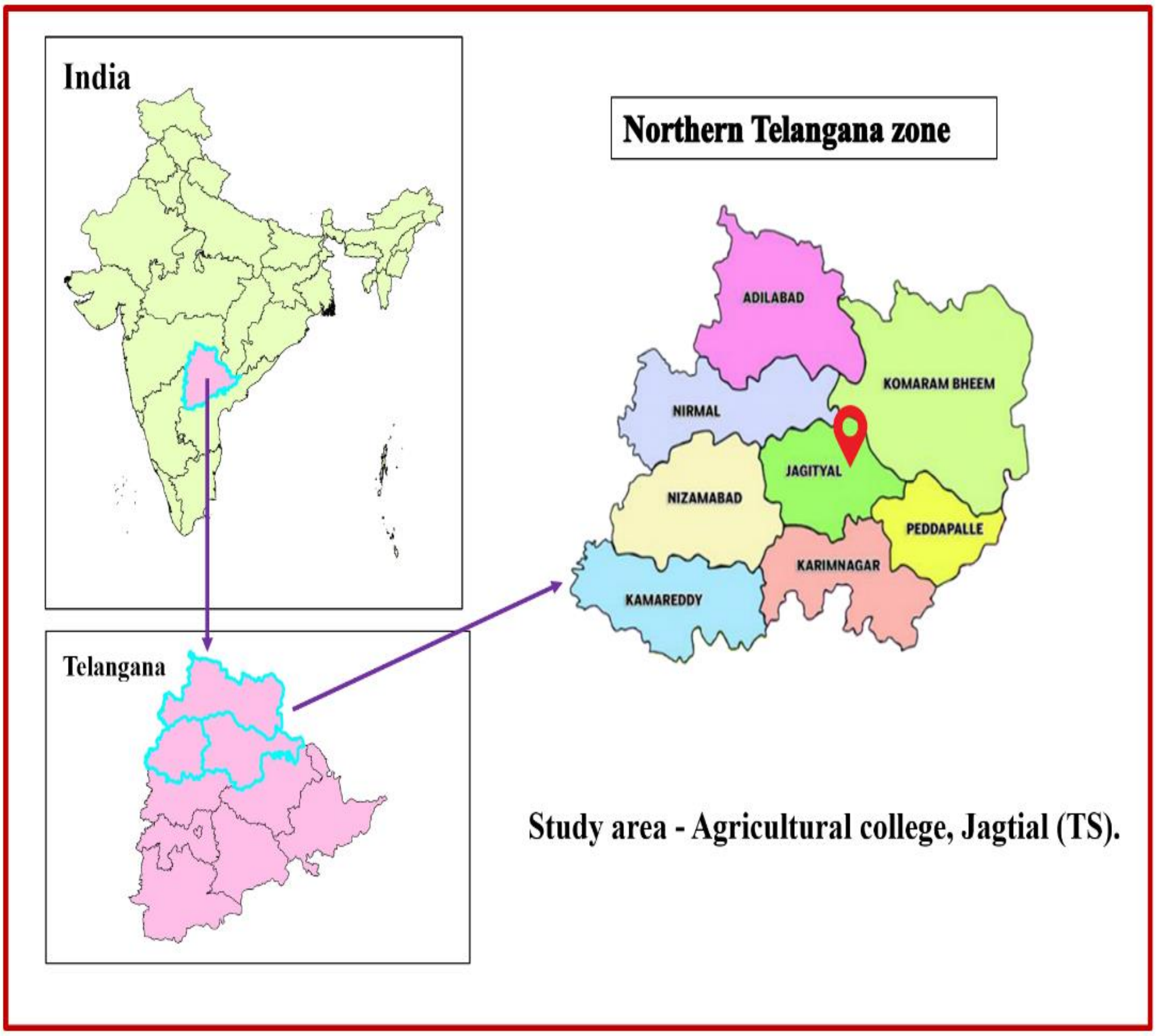

Fig. 1. Location details of experimental area

2.2 Details of Research Program

The experiment was laid out in a split-plot design with six dates of sowing (1st November (D_1), 15th November (D_2), 1st December (D_3), 15th December (D_4), 1st January (D_5) and 15th January (D_6)) as main plot treatments and three varieties (JG-14 (V_1), NBeG-3 (V_2) and NBeG-47 (V_3)) in subplots in three replications. Field preparation and crop management was done according to recommended practices. Fertilizer dose of 20:50:20 NPK kg/ha applied as basal and sowing was done according to treatments with a spacing of 30 cm × 10 cm. Biometric observation at different growth stages was recorded from randomly tagged five plants from each plot. Leaf area is measured by using leaf area metre from which Leaf area index (LAI) was calculated based on formula given by Watson (1947) *i.e.*,

$$LAI = \frac{leaf\ area/plant}{ground\ area/plant}$$

Dry matter production at different growth stages analysed by sampling five plants from each plot and oven dried at 60^0C to a constant weight, from which cop growth rate (CGR) was calculated by using the following formula given by Watson (1952) i.e.,

$$CGR\ (g\ m^{-2}\ day^{-1}) = \frac{W_2 - W_1}{T_2 - T_1}$$

Where: W_1= Dry matter accumulation at T_1 (g/m²), W_2 = Dry matter accumulation at T_2 (g/m²), T_1 = Days at first stage, T_2 = Days at second stage.

Data regarding phenology *i.e.*, number of days to germination, branching initiation, flowering and physiological maturity was noted carefully by monitoring each plot every day during the crop period. Data obtained from the experiment was analysed statistically as described by Gomez and Gomez (1984) by using OPSTAT software. The standard error of mean and critical difference at 5% probability was calculated for each parameter to compare treatment means.

3. RESULTS AND DISCUSSION

3.1 Growth Attributes

3.1.1 Leaf Area Index (LAI)

Leaf area was crucial for crop growth as it played key role in capturing of PAR (Srinivasan et al., 2017). Higher amount of solar radiation was intercepted by presence of more leaf canopy which helped in enhancing photosynthetic rate and ultimately crop biomass (Ali et al., 2021). LAI of chickpea at different growth stages were significantly affected by dates of sowing as summarized in Table 1. Highest LAI at all the stages was observed with crop sown on 1st November (D_1) which was on par with crop sown on 15th November (D_2) in most cases while significantly lowest LAI at all the stages was noticed with crop sown on 15th January. As the late sowing of crop led to expose of crop to harsh weather conditions causing low chlorophyll synthesis and effecting leaf area negatively (Hembram et al., 2025, Ali et al., 2021). Among the varieties NBeG-3 (V_2) showed maximum LAI at all stages and lowest with NBeG-47 (V_3) which might be due to genetic character of the variety (Ali et al., 2021). Whereas interaction among dates of sowing varieties showed no significant effect.

3.1.2 Crop Growth Rate (CGR)

Crop growth rate was the amount of dry matter production (unit time)$^{-1}$ over certain period. CGR was noted highest between flowering to pod formation due to high biomass production during this period (Kour et al., 2016). CGR was calculated between sowing-branching, branching-flowering, flowering-pod formation and pod formation-maturity. Different dates of sowing of chickpea showed significant effect on CGR as shown in Table 1. Crop sowed on 1st November (D_1) showed maximum CGR (0.317, 1.80, 11.056 and 0.949) at various stages respectively and minimum CGR (0.194, 1.023, 4.76 and 0.213) with crop sown on 15th January. Hence, delay in sowing led to decline of biomass production (Kabir et al., 2009) due to rise of temperatures during later stages which ultimately reduced CGR (Vignesh et al., 2024, Kumar et al., 2022a, Hembram et al., 2025). Among the verities NBeG-3 (V_2) showed significantly highest CGR at all stages except at pod formation to maturity, which was on par with JG-14 (V_1) and lowest CGR with NBeG-47 (V_3). Interaction showed no significant effect on CGR**.**

3.2 Crop Phenology

Crop phenology is mainly concerned with the timing of specific stages of crop growth and development in the annual cycle (Piao et al., 2019). The time of occurrence of phenological events of chickpea crop was recorded across all treatments *viz.*, germination, branching initiation, first flowering, first pod formation and physiological maturity stages**.** Data was analysed statistically and summarised in the Table 3. Variation of phenological events is due to prevailing weather conditions during each growth phase. Different weather parameters (temperature, relative humidity, wind velocity and bright sunshine hours) at various phenophases was depicted in Fig. 2.

3.3 Days to Germination

Number of days to germination depended on various internal and external factors such as soil moisture, temperature, light (Bozena, 2023). Different dates of sowing showed significant effect on number of days to germination. D_6 showed maximum days to germination (9.11 days) while minimum days (7.33 days) by D_1. Crop sown in late conditions faced low temperature during sowing which delayed the seed germination (Gupta et al., 2017, Eshan et al., 2023). Varieties and interaction shown no significant effect.

3.4 Days to Branching Initiation

Under different dates of sowing crop sown on 15th November (D_2) took significantly higher number of days (28.78 days) to attain branching initiation stage over other dates of sowing dates while minimum days with 15th January (27.56 days). Among three varieties significantly a greater number of days (29.28 days) to attain branching initiation was taken by NBeG-47(V_3) and a smaller number of days (26.67 days) recorded with JG-14(V_1).

3.5 Days to First Flower Initiation

Crop sown on 1st November(D_1) took significantly a greater number of days (39.56) to first flower appearance compared to other dates of sowing and significantly lowest number of days (29.89 days) were taken to attain first flower in 15th January(D_6) sown crop. The results were in conformity with the findings of Ali et al. (2018). Among varieties, NBeG-47(V_3) showed maximum number of days (36.28 days) to first flower appearance followed by NBeG-3(V2). Interaction effect of dates of sowing and varieties showed significant effect (Table 4.) as D_1:1st November sown crop with V_3: NBeG-47 variety showed significantly a greater number of days (44.33 days) to flower appearance and minimum days (29.33 days) in case of D_6:15th January sown crop with V_1: JG-14 variety. The commencement of the initial flowering was

Table 2. Leaf area index (LAI) and Crop growth rate (CGR) of chickpea at different growth stages as influenced by dates of sowing and varieties

	Branching		**Flowering**		**Pod formation**		**Maturity**	
	LAI	**CGR**	**LAI**	**CGR**	**LAI**	**CGR**	**LAI**	CGR
Dates of sowing (D)								
D1	0.544	0.317	1.221	1.80	1.237	11.056	1.056	0.949
D2	0.318	0.294	1.153	1.672	1.234	10.313	1.054	0.878
D3	0.306	0.269	1.083	1.527	1.14	9.523	0.989	0.88
D4	0.423	0.249	1.127	1.256	1.129	7.862	0.969	0.867
D5	0.309	0.223	1.058	1.166	1.103	7.219	0.921	0.806
D6	0.252	0.194	0.982	1.023	1.057	4.76	0.914	0.213
Sem ±	0.024	0.008	0.033	0.098	0.025	0.341	0.026	0.119
CD (*P*=0.05)	0.075	0.027	0.104	0.313	0.08	1.088	0.083	0.381
Varieties (V)								
V1	0.343	0.266	1.1	1.43	1.142	8.774	0.978	0.769
V2	0.399	0.274	1.163	1.569	1.191	8.974	1.032	0.831
V3	0.333	0.234	1.049	1.223	1.117	7.618	0.941	0.696
Sem ±	0.017	0.007	0.031	0.082	0.015	0.28	0.013	0.053
CD (*P*=0.05)	0.051	0.020	0.09	0.239	0.043	0.81	0.039	NS
Interaction								
D at V								
Sem ±	0.042	0.016	0.069	0.19	0.039	0.649	0.037	0.16
CD (*P*=0.05)	NS	NS	NS	NS	NS	NS	NS	NS
V at D								
Sem ±	0.041	0.014	0.057	0.17	0.043	0.59	0.045	0.207
CD (*P*=0.05)	NS	NS	NS	NS	NS	NS	NS	NS

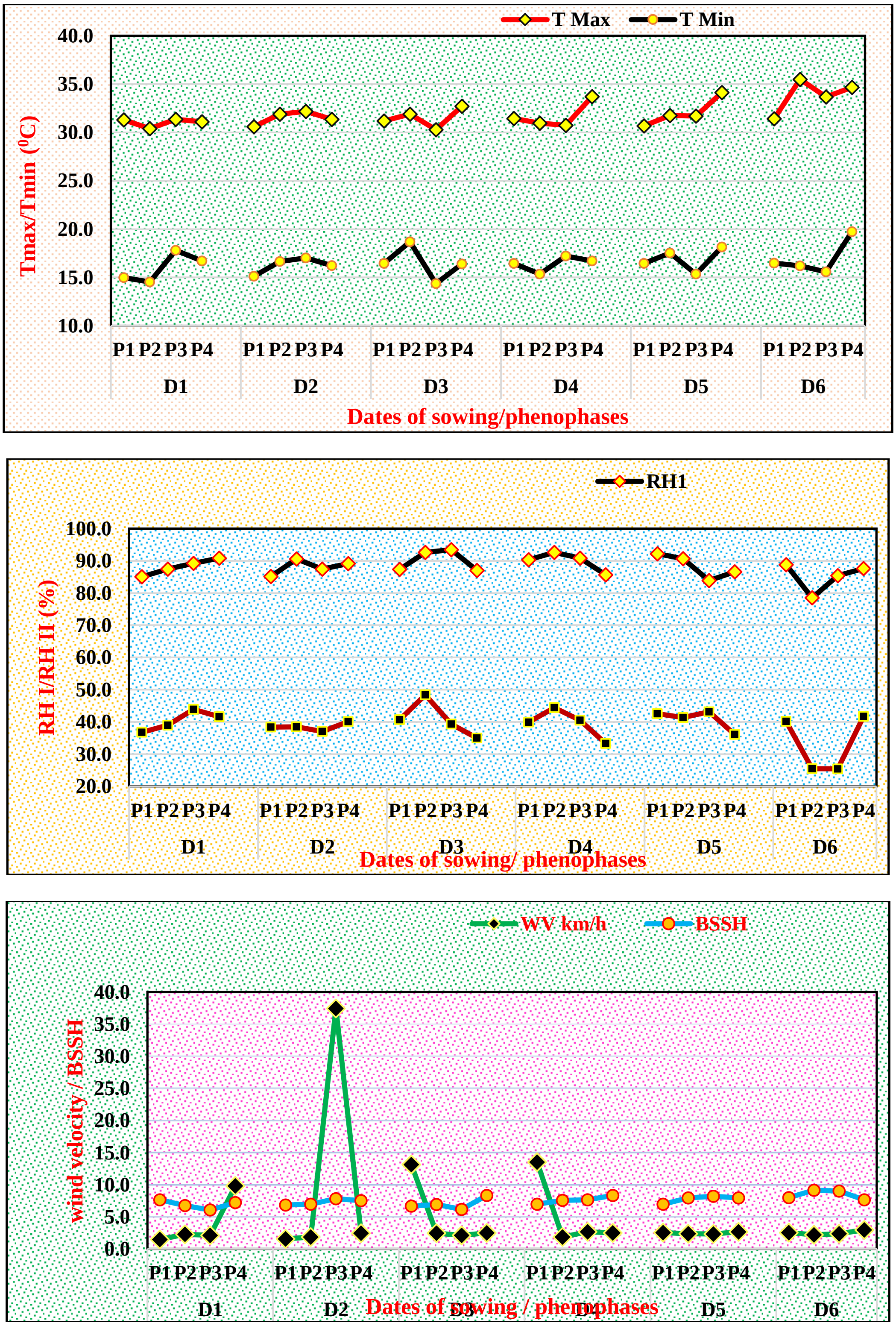

Fig. 2. Mean maximum and mean minimum temperature, morning and afternoon relative humidity, wind velocity and bright sunshine hours during different phenophases of chickpea

**P1-sowing to branching, P2-branching to flowering, P3- flowering to pod formation, P4-pod formation to physiological maturity.*

Table 3. Number of days to attain different phenophases of chickpea as influenced by different dates of sowing and varieties

Treatments	Germination	Branching initiation	First Flower initiation	First Pod formation	Physiological maturity
Dates of sowing (D)					
D_1: 1st November	7.33	28.78	39.56	51.33	94.22
D_2: 15th November	7.77	28.44	37.78	47.00	92.00
D_3: 1st December	7.88	28.22	35.56	44.67	89.56
D_4: 15th December	8.11	27.89	32.33	42.33	88.78
D_5: 1st January	8.66	27.67	31.00	38.78	87.11
D_6: 15th January	9.11	27.56	29.89	37.33	84.11
SEm ±	0.31	0.31	0.38	0.37	0.28
CD (P=0.05)	1.02	0.96	1.20	1.16	0.88
CV (%)		3.3	3.3	2.5	1.0
Varieties (V)					
V_1: JG-14	8.389	26.67	32.50	41.94	82.33
V_2: NBeG-3	8.056	28.33	34.28	43.39	90.61
V_3: NBeG-47	8	29.28	36.28	45.39	94.94
SEm ±	0.195	0.18	0.23	0.25	0.21
CD (P=0.05)	NS	0.52	0.68	0.74	0.62
CV (%)		2.7	2.9	2.5	1.0
Interaction (D x V)					
Factor (A) at same level of B					
SEm ±	0.50	0.43	0.60	0.62	0.52
CD (P=0.05)	NS	NS	1.83	NS	1.53
Factor (B) at same level of A					
SEm ±	0.55	0.52	0.6	0.63	0.52
CD (P=0.05)	NS	NS	1.74	NS	1.57

sensitive to temperature changes and could be delayed by extended exposure to either low or high temperatures. First flowering was known to be delayed by cold temperatures, while early flower initiation could be induced by higher temperatures Kumar et al. (2006).

3.6 Days to First Pod Formation

Crop sown on 1st November (D_1) has showed significantly greater number of days (51.33) to appear first pod formation in turn, 15th January (D_6) recorded the lowest number of days (37.33) for first pod formation similarly stated by Prasanthi et al. (2023). Among the three varieties NBeG-47(V_3) observed greater number of days (45.39) to attain first pod formation while, less number of days for JG-14(V_1) is 41.94. Number of days to attain first pod formation was not influenced by the combined effect of dates of sowing and varieties. Delayed sown crop experienced low temperatures at initial growth stages and high temperature at reproductive stages both the condition caused stress on crop leading to early completion of life cycle (Prasad et al., 2008).

3.7 Days to Physiological Maturity

Delay of sowing gradually decreased the number of days to attain physiological maturity. Under different dates of sowing, 1st November(D_1) took maximum days (94.22) to attain physiological maturity while minimum number of days (84.11) in case of 15th January(D_6). Days to physiological maturity were reduced with delay of sowing similar results were stated by (Singh et al., 2022). Delay in sowing reduced the period of time required to reach physiological maturity. It might be due to rise of temperature during the reproductive phase (Venkatachalapathi and Reddy, 2013). While, NBeG-47(V_3) required higher number of days (94.94) to attain physiological maturity and lowest with JG-14 (82.33). Number of days to physiological maturity was significantly affected by interaction effect of sowing dates and varieties (Table 5.). Maximum days to physiological maturity (101.33) was observed for 1st November(D_1) sowing with NBeG-47(V_3) variety and minimum days to physiological maturity (80.33) for 15th January(D_6) with JG-14 variety.

Table 4. Number of days to attain flower initiation of chickpea as influenced by interaction effect of dates of sowing and varieties

	V_1	V_2	V_3	Mean (D)
D_1	36.33	38.00	44.33	39.56
D_2	35.67	38.00	39.67	37.78
D_3	33.00	35.67	38.00	35.56
D_4	30.67	32.33	34.00	32.33
D_5	30.00	31.67	31.33	31.00
D_6	29.33	30.00	30.33	29.89
Mean (V)	32.50	34.27	36.22	
interaction (D x V)				
SEm ±	0.6			
CD (P=0.05)	1.8			
Interaction (V x D)				
SEm ±	0.6			
CD (P=0.05)	1.7			

Table 5. Number of days to attain physiological maturity of chickpea as influenced by interaction effect of dates of sowing and varieties

	V_1	V_2	V_3	Mean (D)
D_1	85.33	96.00	101.33	94.22
D_2	84.67	92.00	99.33	92.00
D_3	81.00	90.00	97.67	89.56
D_4	81.33	90.00	95.00	88.78
D_5	81.33	90.00	90.00	87.11
D_6	80.33	85.67	86.33	84.11
Mean (V)	82.33	90.61	94.94	
interaction (D x V)				
SEm ±	0.5			
CD (P=0.05)	1.5			
Interaction (V x D)				
SEm ±	0.4			
CD (P=0.05)	1.5			

4. CONCLUSION

Chickpea crop sown under different dates of sowing in Northern Telangana zone (NTZ) has showed decline in plant growth indices (LAI and CGR) and days to maturity with delay in sowing. Highest LAI and CGR with November 1st sowing and lowest with 15th January sowing. Similarly, early sown crop took maximum days to maturity while late sown crop completed early causing low biomass. Hence sowing of crop at optimum dates *i.e*., November 1–30 would help farmers of NTZ to get good yields. Similarly, among three verities examined NBeG-3 is best suited for NTZ under varied dates of sowing.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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