D-6238
[1-6]

RESEARCH ARTICLE Agricultural Science Digest

Crop Weather Relationship of Chickpea under Late Sown Conditions in Northern Telangana Zone (NTZ)

A. Sagar[1], N. Mahesh[1], O. Sampath[1], K. Chandra Shaker[2], G.P. Sathwik[1], S. Vijay[3]

10.18805/ag.D-6238

ABSTRACT

Background: Chickpea one of the major pulse crops grown in rabi season which require optimum weather conditions (cool climate) for growth and development of the plant. Under late sown conditions crop is exposed to higher temperatures during flowering and pod formation stages which show affect on yield of the crop hence optimum sowing time play a major role in crop growth.

Methods: Experiment was carried out in order to investigate the relationships between dry matter accumulation, yield attributes and grain yield with various weather parameters by using correlation and regression analysis. The experiment was conducted in split plot design with 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) in main plots and three varieties *viz*., JG-14 (V_1), NBeG-3 (V_2) and NBeG-47 (V_3) in sub plots replicated thrice was carried out at college farm, Agricultural College, Jagtial, Telangana during *Rabi*, 2022-23 in sandy clay loam soil.

Result: Results of this investigation revealed that chickpea crop sown under different dates of sowing showed that heat units requirement varies from 1714 to 1753 growing degree days (GDD), photo thermal units (PTU) requirement ranged from 19093 to 20505. While, Helio thermal units (HTU) requirement ranged from 12466 to 19093 during the crop growth period. Correlation studies indicated that critical weather influencing the seed yield of chickpea is minimum temperature prevailed at P_4 stage (first pod formation to physiological maturity) which accounted for 68% variation.

Key words: Chickpea, Growing degree days, Helio thermal units, Photo thermal units, Weather.

INTRODUCTION

In developing countries like India people obtain major portion of protein requirement of the body in the form of pulses. Chickpea is one of the major pulse crop which is very healthy as it supply roughly 60-65% carbohydrates, 18-22% protein, 6% fat and rich source of minerals and provides important vitamins such as riboflavin, niacin, thiamine, folic acid and carotene, a precursor of vitamin A (Eshan *et al*., 2023, Cokkizgin *et al*., 2025).

Chickpea is important *rabi* pulse crop cultivated in different parts of the country and world (Jain *et al*., 2023). Major states of India where chickpea is cultivated are Madhya Pradesh, Rajasthan, Karnataka, Uttar Pradesh, Andhra Pradesh, Gujarat, Jharkhand, Chhattisgarh and Telangana (Srinivas *et al*., 2025). India is the largest producer and consumer of pulses with a lion share of 42.6% of area and 28.3% of production globally (Agricoop, 2022). Chickpea contributes about 47% of the total pulse production and about 40% of total pulses growing area in the country. In India, chickpea is a premier pulse crop occupying 9.9 million hectares of land with a production of 11.9 million tonnes and with a productivity of 1192 kg ha^{-1} (Indiastat, 2021). In Telangana, it is cultivated in 1.59 lakh hectares of area with a total production of 224 metric tonnes and with a productivity of 1407 kg ha^{-1} with highest area and production in Kamareddy followed by Adilabad, Nirmal districts (Dept. of Agricultural Co-orperation and Farmer Welfare, 2022).

As chickpea is a *rabi,* crop it requires cool weather for its growth but temperatures start rising from mid-February onwards which adversely affects crop growth and development resulting in early maturity of crop (Chand *et al*., 2010). From previous two decades, climate change has caused variations in the global temperature, leading to a negative impact on crops grown in arid and semi-arid countries. The best sowing time is crucial for the overall growth and development of the plants because chickpea crops are sensitive to temperature variations as early-sown crops are exposed to low temperatures (<5°C) during their vegetative stage in December and January while late-sown crops are exposed to high temperatures (>35°C) during their reproductive stage in February and March (Kumar *et al*., 2023).

[1]Department of Agronomy, Agricultural College, Polasa, Jagtial-505 327, Telangana, India.
[2]Subject Matter Specialist (Crop Production), Krishi Vigyan Kendra, Kampasagar-508 355, Telangana, India.
[3]Department of Agronomy, College of Agriculture, Professor Jayashankar Telangana State Agricultural University, Hyderabad-500 001, Telangana, India.

Corresponding Author: A. Sagar, Department of Agronomy, Agricultural College, Polasa, Jagtial-505 327, Telangana, India.
Email: sagarakarapu11@gmail.com

How to cite this article: Sagar, A., Mahesh, N., Sampath, O., Shaker, K.C., Sathwik, G.P. and Vijay, S. (2025). Crop Weather Relationship of Chickpea under Late Sown Conditions in Northern Telangana Zone (NTZ). Agricultural Science Digest. 1-6. doi: 10.18805/ag.D-6238.

Submitted: 01-11-2024 **Accepted:** 09-06-2025 **Online:** 27-06-2025

As chickpea crop is a photo and thermosensitive crop, various sowing dates may affect the crop different vegetative and reproductive stages as a result of changes in temperature, sunshine hours and day length. Since chickpea needs cool, dry weather for better growth and development, it is grown in the winter months following by monsoon season. (Singh *et al*., 2022). Occurrence of high temperatures during flowering and pod formation under late-sown condition have a negative impact on the crop productivity. This is due to variations in temperature can affect the morphological, physiological and biochemical behaviour of the crop (Moradshahi *et al*., 2004, Patel *et al*., 1997). Present experiment was carried out to study the crop weather relationship of chickpea under different dates of sowing.

MATERIALS AND METHODS

The investigation was carried out during *Rabi* season (2022) at the College Farm, Agricultural College, Jagtial, Professor Jayashankar Telangana State Agricultural University (18°50'37" N and 78°57'6" E and 243.4 m above MSL). The experiment was laid out in split plot design with six dates of sowing *viz*., 1st November, 15th November, 1st December, 15th December, 1st January and 15th January in main plots and three varieties *viz*., JG-14, NBeG-3 and NBeG-47 in sub-plots and replicated thrice. All recommended agronomic practices and plant protection measures were adopted to raise the crop. Daily weather data (maximum temperature, minimum temperature, morning relative humidity, evening relative humidity, bright sunshine hours, rainfall and day length) were collected from the meteorological observatory at the Regional Agricultural Research Station, Jagtial, throughout the crop-growing season. During various stages of chickpea growth, agrometeorological indices such as Growing Degree Days (GDD), Helio Thermal Units (HTU) and Photo Thermal Units (PTU) were calculated.

Growing degree days (GDD)

Growing degree days (GDD) concept was proposed to explain the relationship between growth duration and temperature. It is the mean temperature above base temperature. Mathematically, it can be expressed as

$$\text{Growing degree days (°C day)} = \Sigma \frac{T_{max} + T_{min}}{2} - T_{base}$$

Where,

T_{max} = Maximum temperature (°C).

T_{min} = Minimum temperature (°C).

T_{base} = Base temperature (5°C).

Helio thermal units (HTU)

The product of GDD and the actual number of hours of bright sunshine for a given day is represented by the Helio thermal units for that day. Using the following formula, the HTU for each phenophase's duration was calculated.

$$\text{Accumulated HTU (°C day hr)} = \text{GDD} \times \text{Duration of sunshine hours}$$

Photo thermal units (PTU)

The product of GDD and day duration is represented by the photothermal units for a day. The formula below was used to calculate the total PTU for each phenol phase.

$$\text{Accumulated PTU (°C day hr)} = \text{GDD} \times \text{Day length (hr)}$$

Correlation and regression analysis were carried out by using of IBM SPSS statistics software. Correlation between weather parameters and crop dry matter production, yield attributes and seed yield were carried out. Similarly, step wise regression analysis was used to derive a relation between weather parameters and dry matter production, yield attributes and seed yield.

RESULTS AND DISCUSSION

Agrometeorological indices

Growing degree days (GDD)

During the crop growing season accumulated growing degree days (GDD) for different dates of sowing ranged from 1714 to 1753 with standard deviation of ±13.7 from sowing to physiological maturity. Delay in sowing resulted decrease of accumulated growing degree days due to decrease of number of days to attain physiological maturity. Similar results have also been reported by Eshan *et al*. (2023), Raghavendra *et al*. (2021) and Nikam *et al*. (2015). As reduction of number of days to physiological maturity decreases dry matter accumulation and ultimately yield.

Photothermal units (PTU)

Accumulated photothermal units for each growth stage under different sowing dates was calculated and presented in the Table 1. In case of crop sown on 15th January showed maximum photo thermal units (20505) and minimum (19093) on 15th November with a standard deviation of ±483.9.

Helio thermal units (HTU)

Cumulated Helio thermal units of each stage of crop are computed for different dates of sowing and shown in the Table 1. Results shows that HTU for crop from sowing to physiological maturity was in the range of 12466 to 13847 with a standard deviation of ±536.3.

Relationship between weather parameters and dry matter, yield and yield attributes

Maximum temperature

The correlation studies between dry matter production and maximum temperature (Table 2) showed negative correlation at P_2 (branching initiation to first flower), P_3 (first flower to first pod) and P_4 (first pod to maturity) was -0.87**, -0.60** and -0.84**, respectively and yield attributes, yield also showed negative correlation with maximum temperature. Hence, the rise of temperature during different stages of the crop decreased photosynthesis rate as well as

Table 1: Calendar days and agrometeorological indices during different growth stages of chickpea as influenced by dates of sowing.

Date	Sowing to branching initiation				Branching initiation to first flower				First flower to first pod				First pod to physiological maturity				Sowing to physiological maturity			
	C day	GDD	HTU	PTU	C day	GDD	HTU	PTU	C day	GDD	HTU	PTU	C day	GDD	HTU	PTU	C day	GDD	HTU	PTU
1st November	28	507	3875	5706	12	210	1418	2320	11	215	1289	2369	43	733	5284	8836	94	1746	12466	19433
15th November	29	518	3521	5752	9	174	1198	1909	9	176	1377	1940	45	846	6380	9493	92	1714	12476	19093
1st December	29	546	3636	5782	7	162	1125	1786	9	156	955	1731	45	880	7330	10029	90	1723	12872	19327
15th December	28	531	3706	5846	4	73	534	810	10	190	1449	2121	46	950	7915	10996	89	1743	13605	19773
1st January	28	520	3625	5781	3	60	461	676	8	148	1218	1677	48	1015	8060	11985	87	1742	13364	20118
15th January	28	531	4240	5949	2	41	373	478	7	137	1233	1580	47	1044	8000	12498	84	1753	13847	20505
Mean	28	525	3767	5802	6	120	852	1330	9	170	1254	1903	46	911	7162	10640	89	1737	13105	19708
SD	0.5	13.4	259.7	85.1	3.4	64.2	407.9	701.0	1.2	26.6	155.7	274.1	1.7	105.4	1020.0	1312.2	3.2	13.7	536.3	483.9
CV%	1.8	2.5	6.9	7.7	10.2	12.4	14.6	16.8	19.0	21.2	23.4	25.6	27.8	30.0	32.2	34.4	36.6	38.8	41.0	43.2

* Significant at 5% level; ** Significant at 1% level. Note: P_1= sowing to branching initiation; P_2= branching initiation to first flower; P_3= first flower to first pod; P_4= first pod to maturity; T max= Maximum temperature (^{0}C); T min= Minimum temperature (^{0}C); RHI= Morning relative humidity (%); RHII= Afternoon relative humidity (%); WV= wind velocity (km/h); BSSH= bright sunshine hours (h/day); Eva= evaporation (mm/day); T mean= average temperature (^{0}C); T max-T min (^{0}C).

stomatal conductance resulted reduction of leaf area index, dry matter production, yield attributes and yield (Chakrabarti *et al*., 2013, Satpathi *et al*., 2022).

Minimum temperature

Correlation study between mean minimum temperature and dry matter production (Table 2) showed significant negative correlation at sowing to branching initiation (-0.63**), branching initiation to first flower (-0.66**) and first pod to maturity (-0.91**). The correlation study between minimum temperature and number of branches plant^{-1}, number of pods plant^{-1}, seed index and yield showed significantly negative correlation at first pod to maturity (P_4) stage (-0.77**, -0.72**, -0.75** and -0.83**, respectively) and seed yield was negatively correlated at P_2 (-0.64**) also.

Mean temperature

Significant negative correlation was obtained between mean temperature and dry matter production at P_1 (-0.66**), P_2 (-0.89**) and P_4(-0.928**) stages of crop. Number of branches plant^{-1} were also significant negatively correlated with mean temperature at P_2 (-0.62**) and P_3 (-0.84**). Pods plant^{-1} of chickpea was negatively correlated with mean temperature at P_1 (-0.64**) and P_4 (-0.81**). Seeds pod^{-1} and seed index showed significantly negative correlation at P_2 (-0.86**) and P_4 (-0.67**), respectively. Seed yield of chickpea under different dates of sowing showed significant negative correlation with mean temperature at P_1 (-0.63**), P_2 (-0.82**) and P_4 (-0.85**).

T_{max}-T_{min}

Correlation between T_{max}-T_{min} and dry matter production of chickpea at harvest was showed significant negative correlation at P_2 (-0.66**) and P_3 (-0.65**). Number of branches plant^{-1} (-0.66**) and seed index (-0.66**) was negatively correlated with T_{max}-T_{min} at P_3 stage. Seed yield was found significant negatively (-0.64**) correlated with T_{max}-T_{min} at P_2 stage of crop. However, T_{max}-T_{min} was significant positively (0.92**) correlated with seeds pod^{-1} at P_2 stage.

Morning relative humidity (RH I)

Positive correlation (0.87**) was observed between dry matter production and morning relative humidity at branching to flowering stage (P_2). Number of pods plant^{-1} showed significantly positive correlation with morning relative humidity at P_2 (0.62**) and P_4 (0.62**) stages. But number of seeds pod^{-1} showed negative correlation (-0.74**) at P_2 stage. While, the seed index and seed yield of chickpea were significantly positive correlated (0.77** and 0.85**) with morning relative humidity at branching initiation to first flower stage (P_2).

Afternoon relative humidity (RHII)

Significantly positive correlation (0.84** and 0.73**) was observed between crop dry matter production and afternoon relative humidity at P_2 (branching initiation to first flower) and P_3 (first flower to first pod) stages. Correlation between branches plant^{-1} and RH II showed significantly negative correlation (-0.63**) at sowing to branching initiation (P_1). Significantly positive correlation (0.59**) was observed for pods plant^{-1} at branching initiation to first flower (P_2). Whereas, seeds pod^{-1} showed significantly negative correlation (-0.71**) at branching initiation to first flower (P_2). At branching initiation to first flower (P_2) and first flower to first pod (P_3) afternoon relative humidity showed significantly positive correlation with seed index (0.73** and 0.80**) and seed yield (0.82** and 0.69**). The plant growth and development were improved with increasing humidity, as higher humidity conditions help to keep the stomata open to maintain the photosynthesis process and minimize evaporation process of the plants (Chia and Lim, 2022).

Wind velocity (WV)

Dry matter production of the chickpea was significant negatively correlated (-0.65%) with wind velocity at branching initiation to first flower (P_2). Number of branches plant^{-1} and seeds pod^{-1} were positively correlated (0.71** and 0.76**) with wind velocity at branching initiation to first flower (P_2) stage. Seed yield of chickpea crop sown at different dates was showed significantly negative correlation (-0.64**) with wind velocity at branching initiation to first flower (P_2) stage.

Bright sunshine hours (BSSH)

Dry matter production was significantly positive correlated (0.86**) with bright sunshine hours at branching initiation to first flower stage (P_2). Dry matter production, number of

Table 2: Correlation coefficients between weather parameters during different phenological phases and dry matter production, yield attributes and yield of chickpea.

	T_{MAX}	T_{MIN}	RHI	RHII	WV	BSSH	Evaporation	T_{MEAN}	T_{MAX}-T_{MIN}
Seeds pod^{-1}									
P_1	0.120^{NS}	-0.323^{NS}	-0.270^{NS}	-0.381^{NS}	-0.000^{NS}	-0.016^{NS}	0.167^{NS}	-0.196^{NS}	0.385^{NS}
P_2	0.775**	0.777**	-0.746**	-0.717**	0.767**	-0.729**	-0.748**	-0.869**	0.928**
P_3	-0.113^{NS}	0.264^{NS}	0.325^{NS}	0.171^{NS}	0.138^{NS}	-0.077^{NS}	0.348^{NS}	0.079^{NS}	-0.258^{NS}
P_4	-0.265^{NS}	-0.199^{NS}	0.151^{NS}	0.070^{NS}	0.262^{NS}	-0.189^{NS}	-0.036^{NS}	-0.247^{NS}	-0.101^{NS}
Seed index									
P_1	-0.294^{NS}	-0.348^{NS}	-0.162^{NS}	-0.202^{NS}	0.290^{NS}	-0.642**	0.138^{NS}	-0.408^{NS}	0.205^{NS}
P_2	-0.740**	-0.369^{NS}	0.774**	0.736**	-0.372^{NS}	0.755**	0.780**	0.111^{NS}	-0.223^{NS}
P_3	-0.665**	0.232^{NS}	0.507*	0.805**	0.246^{NS}	-0.522*	0.417^{NS}	-0.355^{NS}	-0.662**
P_4	-0.517*	-0.755**	0.067^{NS}	-0.400^{NS}	0.147^{NS}	0.168^{NS}	-0.478*	-0.670**	0.334^{NS}
Seed yield									
P_1	-0.336^{NS}	-0.586*	-0.410^{NS}	-0.417^{NS}	0.072^{NS}	-0.458^{NS}	0.265^{NS}	-0.632**	0.417^{NS}
P_2	0.850**	-0.649**	0.851**	0.822**	-0.642**	0.837**	0.855**	-0.823**	-0.647**
P_3	-0.558*	0.239^{NS}	0.303^{NS}	0.693**	0.245^{NS}	-0.766**	0.470*	-0.260^{NS}	-0.579*
P_4	-0.786**	-0.830**	0.458^{NS}	-0.043^{NS}	0.391^{NS}	-0.140^{NS}			
Dry matter production at harvest									
P_1	0.328^{NS}	-0.632**	-0.491*	-0.490*	0.111^{NS}	-0.514*	0.286^{NS}	-0.664**	0.470*
P_2	-0.877**	-0.663**	0.879**	0.844**	-0.659**	0.862**	0.894**	-0.898**	-0.661**
P_3	-0.600**	0.305^{NS}	0.417^{NS}	0.739**	0.329^{NS}	-0.763**	0.414^{NS}	-0.248^{NS}	-0.655**
P_4	-0.844**	-0.919**	0.440^{NS}	-0.103^{NS}	0.378^{NS}	-0.136^{NS}	-0.873**	-0.928**	0.024^{NS}
Branches plant^{-1}									
P_1	-0.042^{NS}	-0.664**	-0.589*	-0.639**	0.050^{NS}	-0.231^{NS}	0.411^{NS}	-0.576*	0.635**
P_2	0.577*	0.718**	-0.531*	-0.515*	0.711**	-0.514*	-0.533*	-0.621**	0.957**
P_3	-0.504*	0.438^{NS}	0.347^{NS}	0.544*	0.254^{NS}	-0.771**	0.570*	-0.094^{NS}	-0.666**
P_4	-0.821**	-0.770**	0.567*	0.132^{NS}	0.513*	-0.257^{NS}	-0.789**	-0.841**	-0.163^{NS}
Pods plant^{-1}									
P_1	-0.195^{NS}	-0.671**	-0.555*	-0.560*	-0.045^{NS}	-0.227^{NS}	0.329^{NS}	-0.642**	0.569*
P_2	-0.594**	-0.270^{NS}	0.628**	0.590**	-0.263^{NS}	0.634**	0.622**	0.761**	-0.079^{NS}
P_3	-0.376^{NS}	0.409^{NS}	0.191^{NS}	0.497*	0.301^{NS}	-0.715**	0.533*	-0.008^{NS}	-0.548*
P_4	-0.814**	-0.723**	0.626**	0.195^{NS}	0.474*	-0.319^{NS}	-0.833**	-0.812**	-0.235^{NS}

* Significant at 5% level; ** Significant at 1% level

Note: P_1= Sowing to branching initiation; P_2= Branching initiation to first flower; P_3= First flower to first pod; P_4= First pod to maturity; Tmax=Maximum temperature (°C); Tmin= Minimum temperature (°C); RHI= Morning relative humidity (%); RHII= Afternoon relative humidity (%); WV= wind velocity (km/h); BSSH= bright sunshine hours (h/day); Eva= Evaporation (mm/day); Tmean= Average temperature (°C); T_{max}-T_{min} (°C).

Table 3: Stepwise regression models relating dry matter production, yield attributes and seed yield with weather parameters.

Model	Stage	Regression model	R^2
Model I	Dry matter production at physiological maturity	Y= 2365-67.5**P_4Tmin-7.04*P_1 WV - 24.3 P_3Tmax	0.92
Model II	Number of branches plant^{-1}	Y= 39.78-0.68**P_4Tmax-0.31P_3Tmax	0.76
Model III	Number of pods plant^{-1}	Y= 140.1-3.61**P_4Tmax	0.66
Model IV	Seed index	Y= 92.6-1.95**P_2Tmax-2.15*P_1BSSH	0.78
Model V	Seed yield	Y= 8653.6 -40.37**P_4Tmin	0.68

Note: ** - Significant at 1% level; * - Significant at 5% level.

Y = Predicted value.

P_1BSSH= Bright sunshine hours (hrs/day) during sowing to branching initiation stage.

P_1WV= Wind velocity (km/hr) during sowing to branching initiation stage.

P_2Tmax= Maximum temperature (°C) during branching initiation to first flower phase.

P_3Tmax= Maximum temperature (°C) during first flower to first pod formation phase.

P_4Tmax= Maximum temperature (°C) during first pod to maturity.

P_4Tmin= Minimum temperature (°C) during first pod to maturity.

branches plant^{-1} and number of pods plant^{-1} showed significantly negative correlation (-0.76**, -0.77** and -0.71** respectively) with bright sunshine hour at first flower to first pod formation stage (P_3). Number of pods plant^{-1} showed positive correlation (0.63**) at branching initiation to first flower (P_2). Number of seeds pod^{-1} was significantly negative correlated (-0.72**) at branching initiation to first flower (P_2) formation stage. Similarly seed index was negatively correlated with BSSH at sowing to branching initiation (P_1) while seed index and yield of chickpea under different dates of sowing was positively correlated (0.75** and 0.83**) at branching initiation to first flower (P_2) formation stage.Higher radiation interception by the plant canopy with increase in bright sunshine hours intensifies photosynthesis. This leads to higher accumulation of dry matter by the crop thereby increasing its weight (Sah *et al*., 2019).

Evaporation (Eva)

Significantly positive correlation was existed between evaporation and DMP (0.89**), number of pods plant^{-1} (0.62**), seed index (0.78**) and seed yield (0.85**) at branching initiation to first flower (P_2). However significant negative correlation was noticed between evaporation and dry matter production (-0.87**), number of branches plant^{-1} (-0.78**), seeds pod-1 (-0.74**), number of pods plant^{1} (-0.83**) and seed yield (-0.85**) at first pod formation to maturity stage (P_4).

Regression analysis

Stepwise regression analysis was performed to find out the critical weather parameters responsible for dry matter production, yield attributes and seed yield of chickpea. The regression models obtained were presented in the Table 3.

Regression models for prediction of dry matter production, yield attributes and yields of chickpea

Model I: Dry matter at physiological maturity

The minimum temperature at first pod formation to maturity (P_4), wind velocity at sowing to branching initiation (P_1) and maximum temperature prevailed from first flower to fist pod stage (P_3) accounted for 92% variation in dry matter production at physiological maturity.

Model II: Number of branches plant^{-1}

The maximum temperature at first pod formation to maturity (P^4) and first flower to first pod (P^3) phases has influenced the number of branches plant^{-1} which accounted for 76% variation.

Model III: Number of pods plant^{-1}

Maximum temperature prevailed from first pod formation to maturity (P^4) accounted for 66% of total variation in production of number of pods plant^{-1}.

Model IV: Seed index

The maximum temperature at branching initiation to first flower (P^2) and bright sun shine hours at sowing to branching initiation (P^1) accounted for 78% variation in seed index of chickpea.

Model V: Seed yield

Minimum temperature at first pod formation to maturity stage (P_4) accounted for 68% variation in seed yield of chickpea.

CONCLUSION

Heat units required by the crop from sowing to maturity ranged from 1714 to 1753 GDD, PTU was ranged from 19093 to 20505 and HTU was ranged from 12466 to 13847. Minimum temperature from first pod formation to physiological maturity (P_4) stage accounted for 68% of total variation in seed yield of chickpea and minimum temperature at first pod formation to physiological maturity (P_4), wind velocity at sowing to branching initiation (P_1) and maximum temperature prevailed from first flower to fist pod formation stage (P_3) accounted for 92% variation in dry matter production at physiological maturity. From the crop weather relation, it is concluded that with delay of sowing crop exposed to abnormal weather conditions at different phenological stages resulted in reduction of crop growth and productivity.

ACKNOWLEDGEMENT

The authors are grateful to Professor Jayashankar Telangana State Agricultural University for the providing financial assistance to carry out this experiment.

Conflict of interest

All authors declared that there is no conflict of interest.

REFERENCES

Agricoop, (2022). https://agricoop.nic.in/en.

Chakrabarti, B., Singh, S.D., Kumar, V., Harit, R.C. and Misra, S. (2013). Growth and yield response of wheat and chickpea crops under high temperature. Indian Journal of Plant Physiology. 18: 7-14.

Chand, M., Singh, D., Roy, N., Kumar, V. and Singh, R.B. (2010). Effect of growing degree days on chickpea production in Bundelkh and region of Uttar Pradesh. Journal of Food Legumes. 23: 41-43.

Chia, S.Y and Lim, M.W. (2022). A critical review on the influence of humidity for plant growth forecasting. IOP Conference Series: Materials Science and Engineering. 1257(1): 012001. doi:10.1088/1757-899X/1257/1/012001

Cokkizgin, A., Cokkizgin, H. and Girgel, U. (2025). Salinity Stress: Comparative effects of sodium and potassium salts on chickpea (*Cicer arietinum* L.) germination and vigor. Legume Research. 48(6): 944-950. doi: 10.18805/LRF-848.

Department of Agriculture Co-operation and Farmer Welfare. (2022). https://agri.telangana.gov.in

Eshan, S.S., Hossen, M.S., Islam, M.A. and Islam, M.A. (2023). Chickpea phenology and yield related to agrometeorological indices under different temperature regimes. Journal of Agroforestry and Environment. 16(1): 1-8.

Indiastat.(2021).https://www.indiastat.com/data/agriculture.

Jain S.K., Sharma L.D., Gupta K.C., Kumar Vipen, Yadav M.R. (2023). Variability and character association for yield and quantitative traits under late sown conditions in chickpea (*Cicer arietinum* L.). Legume Research. 46(4): 408-412. doi: 10.18805/LR-4432.

Kumar, A., Kumar, N., Devi, S., Dhaka, A.K. and Khokhar, S. (2023). Physiology and yield of chickpea (*Cicer arietinum* L.) genotypes in response to different sowing dates in semi-arid regions of North India. Legume Research-An International Journal. 46(7): 843-848. doi: 10.18805/LR-5108.

Moradshahi, A., Eskandari, B.S. and Kholdebarin, B. (2004). Some physiological responses of canola (*Brassica napus* L.). Iranian Journal of Science and Technology. 28: 43-50.

Nikam, R.P., Bhondave, T.S. and Raundal, P.U. (2015). Effect of extended sowing dates on growth and yield of chickpea. Journal of Agriculture Research and Technology. 40(1): 51.

Patel, N.R., Mehta, A.N. and Shekh, A.M. (1997). Effect of sowing date and row spacing on phenology and yield of two diverse genotypes of pigeonpea (*Cajanus cajan*). 67(4):153-156.

Ragavendra, T., Sudhakar, P., Rani, P.S., Jayalakshmi, V. and Reddy, B.R. (2021). Photothermal requirement and response of chickpea (*Cicer arietinum* L.) genotypes under different dates of sowing. Andhra Pradesh Journal of Agricultural Science. 7(1): 49-54.

Sah, S., Singh, R.N. and Nain, A.S. (2019). Impact of weather parameters on simulated biophysical parameters of chickpea. Journal of Agricultural Physics. 19(1): 58-66.

Satpathi, A., Nain, A.S. and Setiya, P.(2022). Effect of varying temperature by covered plastic film on growth and development of chickpea. Agricultural Science Digest. doi:10.18805/ag. D-5361.

Singh, V., James, A. and Khangarot, K.S. (2022). An evaluation of the agrometeorological heat indices for different dates of sowing and varieties of chickpeas. International Journal of Environment and Climate Change. 12(11): 2796-2801.

Srinivas, B., Basha, S.A., Sagar, B.V., Kumar, C.V. and Reddy, G.K. (2025). Assessment for chickpea Fusarium wilt in Telangana. Legume Research. doi: 10.18805/LR-5429.