Effect of Different Sowing Environment on Growth Parameters, Yield and Yield Components of Chickpea (*Cicer aretinum* L.) varities

Abstract

A field experiment was conducted during *Rabi* season of 2019-20 in sandy loam soil of C.S.A. University of Agriculture and Technology, Nawabganj, Kanpur (U.P.).The experiment consisted nine treatments combinations comprised of three sowing date/ sowing temperature *viz.*, sowing on November 10 with temperature 22^0C, November 20 with temperature 17^0C and November 30 with temperature 16^0C and three variety viz, KWR-108, KPG-59 and KGD-1168. Results revealed that sowing temperature 22^0C which occurred on November 10 in combination with variety KGD-1168 produced significantly higher growth parameters such as plant population, plant height, number of branches per plant, dry matter accumulation and crop growth rate. It is also evident from data that variety KDG-1168 sown on November 10 has been associated with highest no. of pods plant^{-1}, no. of seeds plant^{-1}, no. of seeds pod^{-1}, test weight, seed yield plant^{-1}, seed yield (q ha^{-1}) because fulfilment of optimum thermal requirement for various plant processes. High temperature during-reproductive stage adversely affected the number of pods plant,$^{-1}$ number of seed pod^{-1} in late sowing (November 30) which ultimately resulted in the lowest seed yield. It can be elaborated from the results that variety KGD-1168 produces higher yield and benefit in the central plain zone of Uttar Pradesh.

Key Words: Chickpea, Plant Height, Seed, Temperature and Yield.

Introduction

Globally, chickpea (*Cicer arietinum* L.) is the second most important legume crop after dry beans. India ranks first in the world, contributing 68% of the global chickpea production accompanied by Australia (60%), Turkey (47%), Myanmar (42%) and Ethiopia (35%) Gaur *et al.*, (2012). In India, it tops the list of pulse crops and is cultivated in 8.32 million ha, producing a total of 7.70 million tons with an average yield of 925.5 kg ha^{-1} (FAOSTAT 2014). From the nutrition perspective, chickpea seed contains 20-30% crude protein, 40% carbohydrate, and 3-6% oil (Hiremath *et al.*, 2019).

India is the largest producer and consumer of pulses in the world. Major pulses grown in India include chickpea, pigeonpea, lentil, urd bean, mung bean, pea, lablab bean, moth bean,

horse bean. Among the pulses, chickpea is the most important grown in every part of India. It is largest produced food legume in South Asia. Chickpea (*Cicer arietinum* L.) is a major legume crop cultivated for its edible seeds legume of the genus *Cicer,* Tribe *Cicereae,* family *Fabaceae* (*leguminaceae*), and subfamily *Papilionaceae*. It provide protein rich diet to the vegetarian of the Indian and complement the stable cereals in the diets with proteins, essential amino acids, vitamins and minerals (Pingoliya *et al.* 2013). They contain 22- 24 % protein, which is almost twice the protein in wheat & thrice that of rice (Shukla *et al.* 2013) and carbohydrate (61.51%), fat (4.5%) and relatively free from anti nutritional factors (Saxena, 1990). Chickpea is rich in protein content (20.47g/100g), carbohydrate (62.95g/100g), fibre (12.2g/100g), phosphorous (252mg/l00g), high amount of minerals such as calcium (57mg/100g), magnesium (79mg/100g), iron (4.31mg/l00g) and zinc (15mg/100g), low in fat content and most of it is polyunsaturated (Wallace *et al.* 2016). Its nomenclature in different countries is well documented as gram, chickpea, hommos, chana, chieting vetch, nakhud, nakhut, kicher, pois chice, garbarzo etc. (Malik *et al.* 2003). Chickpea has many local names: hamaz (Arab world), shimbra (Ethiopia), nohud or lablabi (Turkey), chana (India) and garbanzo (Latin America) (Muehlbauer and Tullu, 1997).

Chickpea is grown in India as post monsoon winter season (*Rabi*) crop as it requires cool and dry weather for optimum growth. Both temperature and moisture supply during the growing period had a strong influence on chickpea. Start of flowering in chickpea is dependent on photothermal conditions (Basu *et al.,* 2009). The most vital step towards enhancing yield of chickpea is to ensure that the phenology of the crop is well in line to resources and constraints of the crop growth and development (Summerfield *et al.,* 1990). Grain yield is significantly sensitive to water stress during the pod setting to grain development periods irrespective of soil texture (Jalota *et al.,* 2006). Higher temperature about 30-35^{o}C has a detrimental effect on growth of chickpea.

Delay in sowing causes early maturity resulting drastic reduction in yield. The productivity of chickpea in eastern U.P. is quite below which needs to be improved by climatic and resource management (Shendge *et al.,* 2002). The unusual weather during reproductive period of a crop adversely affects the crop productivity Plant development depen.ds on temperature and requires a specific amount of heat to develop from one stage in their lifecycle to another, such as from seeding to the harvest stage. Temperature is a key factor for the timing of biological processes and hence regulates the growth and development of plants (Ogbuene, *et al*., 2012).

A quantitative understanding of the response of phenological development to environmental factors helps to predict crop yield. The crop is forced into maturity under hot and dry condition (>30^0C) by reducing the crop duration (Rafi *et al.,* 2015). Temperature based indices like growing degree days (GDD), Heliothermal units (HTU), Pheno-thermal index (PTI), and Heat use efficiency (HUE) can successfully be used for describing phonological behaviour and other growth parameters like leaf area development, biomass production and yield (Wang *et al.,* 2006). Among pulses, chickpea is more sensitive to temperature. The main reason of chickpea flower abortion has been shown when mean daily temperature of less than 15^0C. Late sowing can affect plant height which may reduce vegetative cover and water use efficiency and increase the incidence of insects. Sowing time and cultivars are two important factors which can affect the growth and yield of chickpea (Devasirvatham *et al.,* 2012).

Materials & Methods

Soil of Experimental Field

The soil of the experimental field had originated from alluvial deposits. Soil is sandy loam in texture neutral in reaction (pH 7.04), low inorganic carbon (0.32%), available N (245.10 kg ha^{-1}), in available P (8.60 kg ha^{-1}), medium in available K (121.60 kg ha^{-1}).

Geographical situation of experimental site

The experimental site of C.S.A. University of Agriculture &Technology, Kanpur, geographically, the experimental site is situated at $26^0$29′ N latitude, $80^0$18′E longitude and at an attitude of 125 meters above mean sea level (MSL) in the Indo-gangetic plain. The site comes under sub-tropical climate and often subjected to extremes of weather condition *i.e.* cold winter and hot summer.

Layout and Design of the Experiment

The experiment was laid out in split plot design with four replications. The total numbers of unit plots were 36. The size of a unit plot was 4.5 m X 5.0 m. The width of the main irrigation channel is 1.5 m.

Application of fertilizer

Diammonium phosphate and urea was used to supply nitrogen and phosphorus. An uniform dose of 20 kg N and 60 kg P_2O_5 and 20 kg K_2O were applied through Urea, DAP and MOP, Total quantity of fertilizers were given as basal just below the seed at the time of sowing in the furrows opened by Kudal.

Sowing of seed

Sowing was done as per treatment in rows 30 cm apart opened with the help of Kudal. Seeds were drilled in furrows and covered manually just after sowing.

Observation Recorded

Plant population (m^{-2})

Plant population was counted after complete germination at 30 days after sowing of crop in each individual plot of the experimental field.

Plant height (cm)

Five plants were selected randomly in each plot and tagged to measure height of plants at 30 days intervals from 30 DAS to harvest. It was measured help of meter scale from soil surface to the tips of fully opened leaves.

Number of branches plant^{-1}

Number of branches plant^{-1} were recorded at 30 days interval from sowing the harvest. Five plants were randomly selected for number of branches plant^{-1} and then tagged and total number of branches were counted.

Dry matter accumulation (g m^{-2})

Plants of one meter row length were selected from the border rows of plot and cut down close to the ground surface. These plant samples were collected in paper bags after cutting in small pieces after sundried and then put in an electric oven of at 65 ^{0}C till the constant dry weight and finally dry weight of samples was expressed in g m^{-2}.

Crop growth rate (gm^{-2} days^{-1}) Crop growth rate was worked out by the following formula described by Watson, 1947

$$\text{Crop growth rate} = \frac{W_2 - W_1}{(t_2 - t_1)}$$

Where

W_1 and W_2 are the total dry matter production at the time T_1 and T_2 respectively.

Statistical analysis

The data collected during experimentations were subjected to statistical analysis by applying the procedure given by Fisher and Yates, 1963. The standard error of mean were calculated for each parameters and critical difference (CD) at 5% level of significance were worked out for comparing the treatments means wherever 'F' test was found significant.

Result and Discussion

Initial Plant Population

Data pertaining to initial plant population of chickpea recorded at 30 DAS as influenced by date of sowing/sowing temperature and varieties have been presented in Table-1. Maximum plant population (32.66 m^{-2}) was recorded under sowing done on Nov.10 with sowing temp. /22^{0}C followed by Nov. 20 sowing of chickpea. Delay in sowing recorded the lowest no of initial plant population. It is evident from the data that KGD-1168 variety exhibited maximum initial plant population (32.43) followed by KWR-108 (32.06). The results of the present investigation are also in agreement with the findings of Tiwari *et al.,* 2016), Yadav (2006) and Husnain *et al.,* (2015)

Table- 1: Initial Plant population (m^{-2}) at 30 DAS as affected by sowing date /temperature varieties of chickpea

Treatments	Plant population (m^{-2})
Date of sowing/ sowing temperature	
Nov. 10/ 22^{0}C	32.66
Nov. 20/ 17^{0}C	32.33
Nov. 30/ 16^{0}C]	31.44
SEm±	0.67
CD at 5%	2.07
F- Test	S
Varieties	
KWR-108	32.06
KPG-59	31.94
KGD-1168	32.43
SEm±	0.88
CD at 5%	3.80
F- Test	S

Plant height (cm)

Data pertaining to plant height of chickpea recorded at various growth stages as affected by dates of sowing/sowing temperature and varieties have been presented in (Table-2). It is evident from the data that date of sowing/sowing temperature influenced plant height significantly at all the growth stages. Taller plants were obtained at sowing temperature 22^{0}C (exist on November 10) which was significant over rest both of the sowing dates. Shorter plants were recorded under delayed sowing.

Varieties had significant variation on Plant height at all the stages. It is quite evident from the data that higher plant height was obtained in KGD-1168 which was at par with

KWR-108 at all the stages while significantly superior over KPG-59 variety. Data also showed that KPG-59 variety recorded smaller height of Plant at all the stages. The consequences of the current investigation are additionally in concurrence with the investigation of Agrawal and Upadhyay (2009), Rehman *et al.,* (2015) Sikdar *et al.,* (2015) and Khan *et al.* (2021)

Table- 2: Plant height (cm) at different DAS of chickpea as affected by various treatments

Treatments	DAS			
	30	60	90	At harvest
Date of sowing /sowing temperature				
Nov. 10/22^{0}C	10.73	22.68	48.60	53.24
Nov. 20/17^{0}C	10.32	22.24	48.28	53.52
Nov. 30/16^{0}C	9.69	22.63	45.81	52.46
SEm±	0.234	0.234	0.230	0.312
CD at 5%	0.718	0.717	0.701	1.020
F- Test	S	S	S	45
Varieties				
KWR-108	9.95	22.18	48.10	53.66
KPG-59	10.21	22.27	47.07	52.27
KGD-1168	10.58	23.09	47.53	53.29
SEm±	0.20	0.23	0.26	0.31
CD at 5%	0.86	1.01	1.03	1.07
F- Test	S	S	S	S

Number of branches Plant^{-1}

Data pertaining to number of branches/plant as affected by different treatments are given in (Table-3). It is quite evident from the data that different date of sowing/sowing temperature had significant influence on the number of branches/plant at all the stages of the observation. A cursory glance over data quite reveal that crop sown on Nov.10 with temperature 22^{0}C produced significantly higher number of branches/plant^{-1} was significantly superior over both sowing done on Nov.30 with temperature 16^{0}C and Nov. 20 with temperature 17^{0}C.

The number of branches plant^{-1} was affected significantly by varieties at all the stages. The higher number of branches was recorded with KGD-1168 followed by KWR-108 variety which was significantly superior over KPG-59 at all the stages. The results of the present investigation are also in agreement with the findings of Singh *et al.,* (2014), Singh *et al.,* (2018) and Bhattacharya *et al., (*2019)

Table-3: Number of branches plant^{-1} at different DAS of chickpea as affected by various treatments

Treatments	DAS			
	30	60	90	At harvest
Date of sowing /sowing temperature				
Nov. 10/22^{0}C	2.67	6.11	6.52	7.15
Nov. 20/17^{0}C	2.75	5.59	6.05	6.44
Nov. 30/16^{0}C	2.63	5.66	6.17	6.51
SEm ±	0.067	0.143	0.261	0.144
CD at 5%	0.207	0.440	0.80	0.442
F- Test	S	S	S	
Varieties				
KWR-108	2.49	6.09	6.52	6.64
KPG-59	2.47	5.36	5.89	6.44
KGD-1168	3.08	5.91	6.34	7.01
SEm ±	0.038	0.157	0.157	0.163
CD at 5%	0.117	0.482	0.482	0.499
F- Test	S	S	S	S

Dry matter accumulation

Data regarding dry matter accumulation as influenced by date of sowing/sowing temperature and varieties has been presented in Table- 4. It is quite obvious from the data that dry matter accumulation varied significantly due to date of sowing/sowing temperature at all the stages of chickpea. It was recorded higher under the treatment when chickpea was sown on Nov.10 with sowing temperature 22^{0}C which was at while significantly superior over rest both of the sowing dates. Delayed sowing recorded lowest dry matter at all the stages.

Dry matter accumulation was affected significantly at all the stages due to varieties (Table- 4). Highest dry matter accumulation was recorded in KPG-59 variety followed by KGD-1168 while significant the lowest dry matter accumulated was recorded in KWR-108 at all the stages of chickpea. Data also reveal that KWR-108 variety recorded lowest dry matter accumulation at all the growth stages. Comparative findings were detailed by Fotiadis *et al.* (2017) and Salih *et al.*, (2018)

Table- 4: Dry matter accumulation at different DAS of chickpea as affected by various treatments

Treatments	DAS			
	30	60	90	At harvest
Date of sowing /sowing temperature				
Nov. 10/22^{0}C	126.79	312.80	498.15	794.18
Nov. 20/17^{0}C	123.92	261.60	476.67	766.65
Nov. 30/16^{0}C	122.64	290.12	460.44	738.29
SEm ±	4.043	12.271	15.509	23.855
CD at 5%	12.40	37.658	47.594	73.208
F- Test	S	S	S	S

Varieties				
KWR-108	123.82	285.35	478.52	766.54
KPG-59	123.79	293.06	477.37	766.05
KGD-1168	125.75	286.10	479.37	766.53
SEm ±	1.10	8.64	1.32	0.70
CD at 5%	4.74	37.31	5.70	3.00
F- Test	S	S	S	S

Crop growth rate

Data pertaining to crop growth rate of chickpea recorded at successive growth stages have been presented in (Table- 5). A critical examination over data quite reveal that CGR increased successively till 60-90 DAS and thereafter declined slowly irrespective of various sowing date and varieties. Highest CGR at all the stages was recorded in Nov.10 sowing/ sowing temp. of 22^0C followed by Nov.20 sowing. However, delay in sowing recorded lowest CGR value at all the stages.

Different varieties had marked variation on CGR at all the stages (Table- 5) KGD-1168 variety of chickpea showed the highest CGR at all the stages followed by KPG-59 and then KWR-108. The consequences of the current investigation are additionally in concurrence with the investigation of Soltani *et al.*, (2006) and Ramteke *et al.*, (1996) and Sah *et al.* (2019)

Table- 5: Crop growth rate at different DAS of chickpea as affected by various treatments

Treatments	**DAS**			
	30-60	**60-90**	**90-120**	**120-harvest**
Date of sowing /sowing temperature				
Nov. 10/22^0C	7.33	7.98	7.43	5.00
Nov. 20/17^0C	6.79	8.16	6.69	4.75
Nov. 30/16^0C	6.07	7.77	7.04	4.97
SEm ±	0.0181	0.192	0.231	0.157
CD at 5%	0.557	0.590	0.709	0.482
F- Test	S	S	S	
Varieties				
KWR-108	6.77	7.93	6.92	5.04
KPG-59	6.48	7.51	7.10	4.56
KGD-1168	6.94	8.07	7.14	4.72
SEm ±	0.128	0.064	0.170	0.064
CD at 5%	0.394	0.197	0.521	0.197

Yield Components and yields

Yield Components

Data pertaining to yield components viz: number of pods Plant^{-1}, number of seeds plant^{-1}, number of seeds pods^{-1} and test weight as affected by date of sowing/sowing temperature and varieties have been presented in Table- 6. Higher number of Pods Plant^{-1} (56.12), number of seeds plant^{-1} (160.19), number of seeds pod^{-1} (1.80) and test weight (25.19g) were recorded when crop was sown on Nov.10 with sowing temperature 22^{0}C which was significantly superior over Nov. 20 with sowing temperature 17^{0}C and Nov. 30 with sowing temperature 16^{0}C. The lowest number of pods Plant^{-1}, number of seeds plant^{-1}, number of seeds pods^{-1} and test weight was recorded when sowing was done on Nov. 30 with sowing temperature 16^{0}C.

Number of pods Plant^{-1} was significantly affected by different varieties. Higher number of pods Plant^{-1} (55.28), number of seeds plant^{-1} (154.90), number of seeds pods^{-1} (1.70) and test weight (24.72 g) were recorded with KWR-108 variety followed by KGD-1168 (54.95) and then KPG-59. Comparative findings were detailed by Kumar *et al.,* (2016), Yadav *et al.*, (2019) and Singh *et al.* (2018)

Seed yield (q ha^{-1})

Data pertaining to seed yield of chickpea as affected by date of sowing/sowing temperature and varieties have been given in Table- 6.

Different date of sowing/sowing temperature brought significant influence on seed yield of chickpea. Higher seed yield (22.18 q ha^{-1}) was recorded under sowing done on Nov. 10 with sowing temperature 22^{0}C which was significantly superior over sowing done on Nov. 20 with temperature 17^{0}C followed by sowing done on Nov. 30 with sowing temperature 16^{0}C. Seed yield of chickpea was affected significantly due to different varieties. Higher seed yield (21.18 q ha^{-1}) was recorded in KWR-108 variety which was significant over KPG-59 (21.16 q ha^{-1}) and KGD-1168 (21.09q ha^{-1}.)

Different dates of sowing and varieties have marked variation on the average temperature during crop period and seed yield of chickpea table 6. It is obvious from the data that delay in sowing reduced the seed yield. The consequences of the current investigation are additionally in concurrence with the investigation of Sadeghipour *et al.* (2012), Varoglu *et al.*, (2019), Torkaman *et al.*, (2020) and Rajpoot *et al.*, (2020)

Table- 6: No. of pods plant^{-1}, No. of seeds plant^{-1}, No. of seeds pod^{-1}, test weight, seed yield plant^{-1}, seed yield (q ha^{-1}) at different DAS of chickpea as affected by various treatments

Treatments	No of Pods	No of Seeds	No of Seeds	Test weight	Seed Yield

	plant^{-1}	Plant^{-1}	pod^{-1}	(g)	(qha^{-1})
Date of sowing /sowing temperature					
Nov. 10/22^{0}C	56.12	160.19	1.80	25.19	22.18
Nov. 20/17^{0}C	55.61	156.25	1.76	24.53	21.00
Nov. 30/16^{0}C	52.22	148.37	1.65	23.13	20.11
SEm±	0.240	0.521	0.00	0.219	0.111
CD at 5%	0.737	1.599	0.00	0.671	0.341
Varieties					
KWR-108	55.28	154.90	1.70	24.72	21.18
KPG-59	53.81	153.95	1.72	23.83	21.16
KGD-1168	54.95	155.94	1.78	24.30	21.09
SEm ±	0.17	.0.29	0.001	0.24	0.24
CD at 5%	0.73	1.27	0.05	1.05	1.02

Conclusion

On the basis of result it can be concluded that November, 10 sown crop with sowing temperature 22^0**C** produced significantly higher growth, yield attributes and yield due to fulfilment of optimum thermal requirement at various phenophases of chickpea. High temperature during reproductive stage adversely affected the number of pods plant^{-1}, number of seeds plant^{-1}, number of seeds pod$^{,-1}$ in delayed sowing (November, 30) which resulted significantly lowest yield of chickpea. KGD-1168 variety was found more conductive for growth, development and yield under different growing environments of chickpea.

Thus it can be recommended to farmers of central plain zone of Uttar Pradesh for production of higher chickpea yield that they should grow variety KGD-1168 by November, 10 so that they may get more profit.

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