Studies on Dynamics of Growth Pattern in Chickpea and their Correlations to Seed Yield under Different Sowing Dates in North–West India

ABSTRACT

The experiment was conducted with ten genotypes of chickpea (*Cicer arietinum* L.) *viz* ICCV 88503, ICCV 92944, HC- 1, HC-3, HC-5, H12-64, H13-01, H13-02, H14-01 and H14-04 for three dates of sowing *i.e* 15th October, 15thNovember and 15thDecember at the field in randomized block design during *Rabi* season of 2017-18 and 2018-19 at Pulses Section, Chaudhary Charan Singh Haryana Agricultural University, Hisar to observe the effect of sowing dates on vegetative and reproductive growth rate of chickpea genotypes at different intervals *i.e* 30, 60, 90, and 120 DAS with their correlations to seed yield. The dry weight of leaves, stem, pods, plant height, crop growth rate, relative growth rate and pollen viability were minimum in 15thDecember sowing and maximum in 15thOctober sowing at all intervals. Among genotypes, maximum dry matter and growth rate were observed in H12-64 and H13-01 while minimum were found in H14-04. Seed yield exhibited significant positive correlation with all traits in 15th October and 15th November sowing while non-significant was on 15th December sowing.

Keywords: *Sowing dates, Growth rate, Genotypes, Dry weight, Chickpea*

1. INTRODUCTION

"Chickpea is cool season crop cultivated throughout the world. In India, Madhya Pradesh, Rajasthan, Maharashtra, Uttar Pradesh, Andhra Pradesh, Karnataka, Chhattisgarh, Bihar and Jharkhand are major chickpea cultivating and producing states contributing more than 95% to the total chickpea area and production". (Anonymous, 2018-19).

"In northern part of India, it is normally sown during second fortnight of October. Sometime its sowing is delayed depending upon the withdrawal of monsoon and late harvest of preceding *kharif* crop like rice and sugarcane which ultimately results in poor yield" (Wang *et al*., 2006).

"Analysis of crop growth and development gives an insight not only on the performance of a particular genotype but also impact on production potential of particular crops. Therefore optimum sowing time plays an important role to fully exploit the production potential of a cultivars as it provides optimum growth conditions such as temperature, light, humidity and rainfall". (Anonymous, 2018-19).

"Sowing time play a vital role in influencing the growth of chickpea particularly through prevailing temperature during germination and reproductive phases as pulses are sensitive to change in temperature and the late-sown crop is exposed to high temperatures (>35^{0}C) at its reproductive stage in the months of February and March and low temperature (>5^{0}C) at vegetative stages in the months of December and January" (Berger *et al.,* 2011; Kumar *e tal.*, 2012). "The high temperature at late sown condition may adversely affect the growth and productivity of crops as both duration and grain filling stages are sensitive to alteration in temperature"(Moradshahi*et al*.,2004). "However, during early sown conditions, temperature below 10 ^{0}C is also causes drastic changes in physiological processes ranging from plant water status, photosynthesis to reactive oxygen species (ROS) and crop growth rate, dry matter production, flowering or polen viability and has adverse effect on chickpea production and results in losses from 15-20 %" (Ali and Kumar, 2005; Bakht *et al.,* 2006; Chaturvedi *et al.,* 2009).

2. MATERIALS AND METHODS

Hisar is located in Indo Gangetic plains of North-West India at 215.2 meters above mean sea level with latitude of 29° 10´ North and longitude of 75° 46´East. The climate of Hisar can be classified as tropical, semiarid and hot which is mainly dry with very hot summer and cold winter. The values of weather parameters were taken from observatory located in the research farm of Agro meteorology department in Hisar Agricultural University (Figure 1 and 2). All the parameters were measured at different growth stages *i.e*30, 60, 90 and120 DAS (days after sowing). The five randomly selected plants from each plot were uprooted and sun dried. The dry weight of stem, leaves and pods were taken and average was recorded. For plant height, the perpendicular distance from the ground level to the tip of the plant was measured in centimetre. CGR was measured by using the following formula (Reddy and Reddy, 2009): CGR = (W2- W1) / P (T2- T1)Where, P is the land area and W1 and W2 are dry weights at T_1 and T_2 time, respectively.RGR was measured by the following formula (Reddy and Reddy, 2009): RGR= (LogeW2- LogeW1) / (T2-T1)Where, W_1 and W_2 are dry weights at T_1 and T_2 time, respectively.Viability of freshly released pollen grains was assessed by 2,3,5 triphenyl tetrazolium chloride (TTC) test (Hauser and Morrison, 1964) at

All the collected data were statistically analyzed by pooled analysis of both year (2017-18 and 2018-19) through OPSTAT software at the Computer Centre, Department of Statistics, CCS HAU, Hisar.

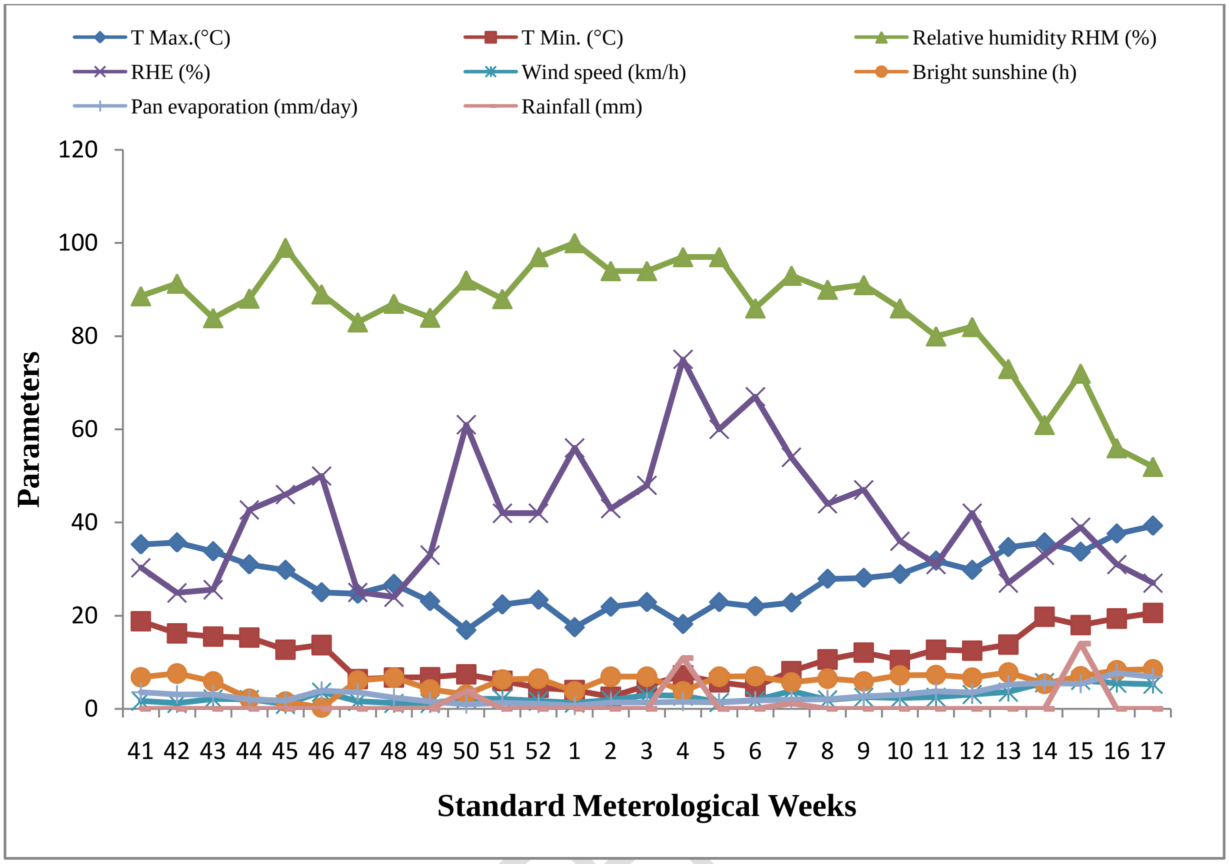

Fig. 1: Values of weather parameters during cropping season of 2017-18.

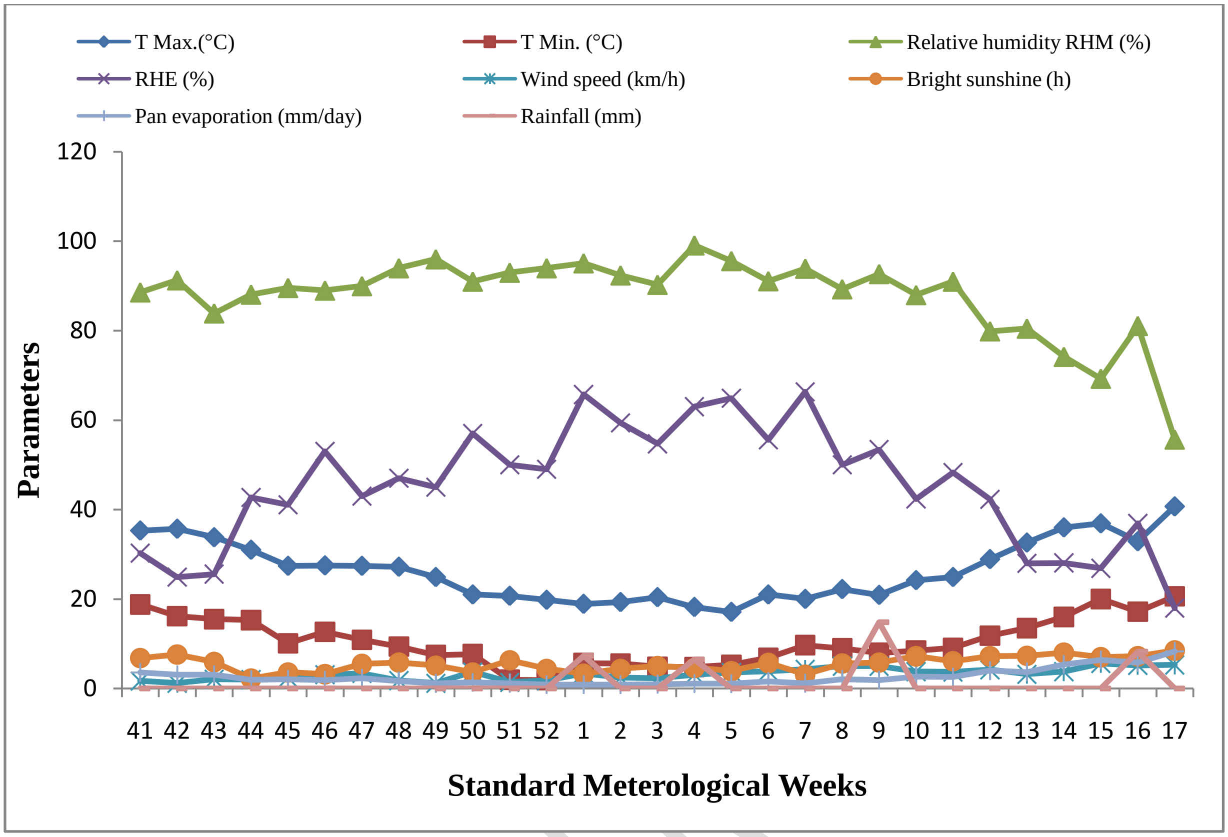

Fig. 2: Values of weather parameters during cropping season of 2018-19.

3. RESULTS AND DISCUSSION

In the present investigation the decreasing trend was observed for dry matter production and its distribution in component parts with delayed sowing from 15th October. The rate of dry matter accumulation in stem and leaves at different sowing dates was increased with the advancing age of the crop but dry weight of leaf declined towards maturity in all genotypes due to the translocation of stored photosynthates from source towards the sink. The highest dry matter was observed in genotypes sown on 15th October and declined with delayed sowing (Table 1). Among the genotypes maximum dry weight of leaf and stem were observed in H12-64 and H13-01 and minimum were recorded in H14-04 at all the growth stages (30, 60, 90, 120 DAS). This might be due to differential growth potential of the genotypes. The reduction in dry matter of leaf and stem beyond 15th October sowing date was due to curtailment of the growth period by 30 days in 15th November and 60 days in 15th December sowing. The later a crop is planted the shorter the potential season for growth and development. Similar results due to different sowing dates on dry matter accumulation in chickpea also observed by (Onyari*et al,.* 2010; Sekhar *et al*,. 2015; Pawar, 2015; Ray *et al*,. 2017).

Table.1: Effects of sowing dates on dry weight of leaves and stem (gm)

	Dry weight of leaves (gm)				Dry weight of Stem (gm)			
Sowing dates	**30 DAS**	**60 DAS**	**90 DAS**	**120 DAS**	**30 DAS**	**60 DAS**	**90 DAS**	**120 DAS**
15th Oct	0.46	1.47	3.86	4.81	0.23	2.68	3.95	6.46
15th Nov	0.38	1.42	3.81	4.66	0.20	2.57	3.92	5.80
15th Dec	0.30	0.95	2.61	3.31	0.14	1.87	2.70	4.18
CD at 5%	0.05	0.01	0.04	0.05	0.03	0.04	0.05	0.08
Genotypes								
H12-64	0.411.31	3.46	4.29	0.20	2.39	3.54	5.53	
H13-01	0.41	1.31	3.46	4.29	0.20	2.39	3.54	5.52
H13-02	0.40	1.30	3.45	4.28	0.20	2.38	3.53	5.51
H14-01	0.38	1.28	3.44	4.28	0.20	2.39	3.53	5.51
H14-04	0.36	1.24	3.39	4.23	0.17	2.33	3.49	5.46
HC 1	0.371.273.42	4.25	0.19	2.36	3.51	5.48		
HC 3	0.37	1.27	3.41	4.25	0.19	2.35	3.52	5.47
HC 5	0.37	1.27	3.42	4.25	0.18	2.35	3.51	5.49
ICCV88503	0.38	1.27	3.42	4.26	0.19	2.37	3.53	5.51
ICCV92944	0.38	1.27	3.42	4.25	0.18	2.36	3.52	5.50
CD at 5%	0.09	0.03	0.08	0.10	0.06	0.07	0.09	0.14

In the present investigation, the dry weight of pods and plant height reduced with delayed sowing due to change in climatic variables especially rise in temperature. The dry weight of pods and plant height increased gradually from flowering to pod maturation and remained almost constant thereafter till maturity. Significantly the highest and lowest dry weight of pods and plant height were observed at 15th October and 15th December sowing date, respectively at 30, 60, 90 and 120 DAS (Table 2). This might be due to congenial environmental conditions *i.e.* optimum temperature and sunshine hours that prevailed during 15thOctober sowing date. The genotype H13-01 recorded highest dry weight of pods and plant height at all critical growth stages (30, 60, 90 and 120 DAS) and lowest in H14-04. This variations might be due to different growth potential of the genotypes. Similar results due to different sowing dates on plant height in chickpea also observed by (Mrudula *et al*,. 2013; Rehman *et al*,. 2015; Sekhar *et al*,. 2015; Pawar, 2015; Patil *et al*,. 2017).

Table.2: Effects of sowing dates on dry weight of pods, plant height and pollen viability

Dry w.t of pods (gm/plant)			Plant Height (cm)				Pollen Viability (%)
Sowing dates	**100 DAS**	**120DAS**	**30 DAS**	**60 DAS**	**90 DAS**	**120 DAS**	**80-90DAS**
15th Oct	5.15	8.19	10.5	25.1	55.3	72.2	69.14
15th Nov	5.09	8.15	9.9	23.6	53.1	69.5	69.01
15th Dec	4.07	6.09	9.1	19.5	43.5	59.7	57.50
CD at 5%	0.06	0.10	0.5	0.04	0.4	0.4	2.05
Genotypes							
H12-64	4.81	7.53	10.9	23.7	53.3	70.8	73.05
H13-01	4.80	7.52	10.9	23.6	53.1	70.6	73.01
H13-02	4.78	7.49	10.6	23.4	52.3	69.3	69.79
H14-01	4.79	7.51	10.2	23.3	50.4	67.6	68.31
H14-04	4.72	7.43	8.1	20.3	43.8	62.0	60.47
HC 1	4.76	7.46	9.8	22.7	49.4	65.4	64.71
HC 3	4.76	7.47	9.4	22.6	47.9	65.6	66.44
HC 5	4.75	7.46	9.3	22.5	47.4	65.1	65.71
ICCV88503	4.77	7.47	9.5	22.9	49.7	66.2	66.85
ICCV92944	4.77	7.47	9.4	22.8	48.7	65.9	66.54
CD at 5%	0.11	0.18	0.9	0.08	0.7	0.7	2.10

In current study, the pollen viability in chickpea differed significantly at 50 % flowering stage (80-90 DAS). Among three dates of sowings lowest pollen viability was recorded in crop sown on 15th December and highest in 15th October and 15th November sowing. This might be due to comparatively high temperature (28.9^{O}C) prevailing at 50% flowering in 15th December sowing than 15th October and 15th November sowing (22.2^{O}C). The data in table 2 showed that highest pollen viability in genotypes was recorded in genotypes H12-64 and H13-01 whereas, minimum pollen viability was in H14-04 this might be due to their different tolerance behavior of genotypes against temperature stress. Similar results due to temperature variation also observed by Krishnamurthy *et al*. 2011; Upadhyaya *et al*. 2011 and Nayyar *et al*. 2005 in chickpea, Pressman *et al*. 2006 in tomato and Snider *et al*. 2011 in cotton.

The data presented in table 3 indicated that the minimum CGR and RGR were observed in 15th December and maximum CGR and RGR were observed on 15th October sowing at all the growth stages (0-30, 31-60, 61-90 and 91-120 DAS) of crop. This might be due to that the high temperature at initial stages in 15th October sowing resulted into accelerated plant growth that produces more dry matter which resulting into increased plant growth rate (CGR and RGR) while in 15th December sowing, low temperature at vegetative phase and high temperature at reproductive phase could be accounted by low dry matter production that resulted into decreased plant growth rate (CGR and RGR) at all the growth stages.

Table.3: Effects of sowing dates on crop growth rate and relative growth rate

Crop Growth Rate (g $m^{-2}day^{-1}$)					Relative Growth Rate (g $g^{-1}day^{-1}$)			
Sowing dates	**30 DAS**	**60 DAS**	**90 DAS**	**120 DAS**	**30 DAS**	**60 DAS**	**90 DAS**	**120 DAS**
15th Oct	0.027	0.128	0.310	0.217	0.0087	0.0362	0.0362	0.0055
15th Nov	0.025	0.122	0.301	0.191	0.0080	0.0358	0.0358	0.0052
15th Dec	0.018	0.081	0.237	0.133	0.0063	0.0177	0.0177	0.0048
CD at 5%	0.001	0.002	0.006	0.003	0.001	0.0001	0.0001	0.0001
Genotypes								
H12-64	0.027	0.120	0.295	0.191	0.0082	0.0126	0.0302	0.0053
H13-01	0.026	0.119	0.295	0.191	0.0082	0.0126	0.0302	0.0053
H13-02	0.025	0.119	0.285	0.191	0.0078	0.0125	0.0300	0.0052
H14-01	0.024	0.105	0.288	0.183	0.0077	0.0118	0.0299	0.0052
H14-04	0.021	0.104	0.274	0.169	0.0071	0.0116	0.0296	0.0049
HC 1	0.022	0.104	0.276	0.173	0.0072	0.0119	0.0296	0.0052
HC 3	0.023	0.104	0.287	0.173	0.0075	0.0117	0.0300	0.0051
HC 5	0.023	0.104	0.276	0.172	0.0072	0.0118	0.0296	0.0052
ICCV88503	0.024	0.119	0.282	0.185	0.0083	0.0125	0.0305	0.0052
ICCV92944	0.022	0.104	0.276	0.173	0.0071	0.0119	0.0296	0.0051
CD at 5%	0.001	0.004	0.009	0.006	0.001	0.0002	0.0002	0.0001

Among the genotypes maximum CGR and RGR were observed in H12-64 and H13-01 and minimum were recorded in H14-04 at all the growth stages (0-30, 31-60, 61-90 and 91-120 DAS). The variation in these genotypes might be due to their genetic makeup. Similar results due to different sowing dates has also been reported earlier in the literature by (Kabir *et al*,. 2009 in chickpea, Alam *et al,.* 2014;Solanki and Mundra, 2015; Khayat *et al,.* 2016 in *Brassica juncea.*

Table.4: Correlations of different parameters with seed yield

Traits	Growth stages (DAS)	15th October	15th November	15th December
Plant Height	**30**	0.810**	0.767**	0.545 NS
	60	0.860**	0.901**	0.445NS
	90	0.810**	0.872**	0.565NS
	120	0.810**	0.824**	0.421NS
	SY	1.000	1.000	1.000
DW	**30**	0.766**	0.814**	0.436NS
	60	0.777**	0.854**	0.478NS
	90	0.750*	0.809**	0.375NS
	120	0.807**	0.817**	0.308NS
	SY	1.000	1.000	1.000
CGR	**0-30**	0.747*	0.780**	0.457NS
	31-60	0.678*	0.669*	0.730*
	61-90	0.662*	0.965**	0.437NS
	91-120	0.759*	0.743*	0.623NS
	SY	1.000	1.000	1.000
RGR	**0-30**	0.685*	0.772**	0.111NS
	31-60	0.681*	0.583NS	0.116NS
	61-90	0.694*	0.644*	0.251NS
	91-120	0.377NS	0.170NS	0.621NS
	SY	1.000	1.000	1.000
PV	**80-90**	0.821*	0.815*	0.611NS
	SY	1.000	1.000	1.000

Abbreviations:DW= Dry weight, CGR= Crop growth rate, RGR= Relative growth rate, PV= Pollen Viability

Correlations with seed yield: Seed yield exhibited significant positive correlation with all traits in 15th October and 15th November sowing while non-significant was on 15th December sowing (Table 4).

Recommendations and Suggestions: In North- West India the chickpea crop should be sown in between 15th October to 15th November to obtain maximum production potential of the crops. Chickpea genotypes H12-64 and H13-01 should be used for early and late sown conditions in the part of North- West India.

4. CONCLUSION

Dry matter production, growth rate and pollen viability of chickpea genotypes varied due to sowing dates. With delay in sowing from 15th October to 15th December, there were decrease in growth rate, dry matter production and pollen viability of chickpea. Average over sowing dates the values of growth rate, dry matter production and pollen viabilitywas highest in genotypesH12-64 and H13-01 whereas lowest values was in H14-04. So it is concluded that chickpea genotypes H12-64 and H13-01 were found to be promising in all the sowing dates and can be used in further breeding programme of chickpea for early (cold tolerance) and late (heat tolerance) sown conditions.

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