Review Article

Assessment of Genetic Variability in Physiological Traits on Chickpea in three Sown Environments

ABSTRACT

The chickpea crop is overly sensitive to abiotic factors; high temperature is one of them, which affects growth and development and yielding potential of the crop. the present studies were conducted to the estimation of genetic variability and heritability for physiological traits in chickpea (*Cicerarietinum* L.) under Randomized Completely Block design with two replications in the field of the department of Plant Breeding and Genetics, of RAK College of Agriculture, Sehore (MP), during the crop season 2019- 2020. The high heritability were observed for LA at 45 DAS (99.22%, 99.61%, 93.87%) & 60 DAS (99.87%, 99.88%, 98.91%), LAI at 45 DAS (99.18%, 99.6%, 93.64%) & 60 DAS (99.86%, 99.89%, 98.92%), TDM at 45DAS (97.21%, 9.13%, 99.05%) & 60 DAS (99.2%, 99.59%, 99.55%), NAR (98.06%, 97.24%, 92.9%), CGR (98.62%, 99.28%, 99.18%), chlorophyll index (SPAD) (95.23%, 94.72%, 82.59%) in normal, late and very late sowing conditions as well as the collection of genotypes for these traits could be useful in the above-mentioned environments. As a result, most of the characters were highly heritable and less influenced by the environment The high Genetic advance as per mean was observed for LA at 45 DAS (73.17%, 91.15%, 60.49%) & 60 DAS (85.11%, 64.40%, 68.11%), LAI at 45 DAS (73.12%, 91.06%, 60.07 %) & 60 DAS (85.07%, 64.37%, 68.15%), TDM at 45DAS (70.40%, 74.89%, 53.54%) & 60 DAS (71.79%, 65.27%, 39.49%), NAR (160.61%, 53.33%, 81.64%), CGR (79.16%, 73.90%, 60.10%), chlorophyll index (SPAD) (59.37%, 52.58%, 43.00%) in E-I, E-II & E-III sown environments, which suggested that these characters can be useful for selecting higher yielding genotypes.

Keywords: genotypes, environments, chlorophyll index, LAI, heritability, genetic advance

INTRODUCTION

Pulses, generally known as food legumes, belonging to family Fabaceae are an important group among staple pulse crops, next only to cereals providing vital protein and vitamins across the world. They form a major and cheapest source of dietary protein especially for vegetarians which form a major part of our Indian population. Pulses are rich source of minerals like calcium, phosphorus, iron and also certain essential amino acids. Thus, inadequate intake of pulses could lead to serious consequences on human health. Chickpea is a cool season crop and an important source of protein. Chickpea is a food legume grown primarily in arid and semiarid zones in India, where it is frequently subjected to drought and high temperatures during the reproductive stage. Chickpea flowering and podding are highly sensitive to changes in the external environment, with drastic reductions in seed yields reported when plants are exposed to high temperatures (Bahuguna *et al*. 2012). Chickpeas are well tailored for growth and pod filling in a range of temperatures 30-15°C (Basu *et al*. 2011).Temperature plays a major role in pheno-phases *i.e.*, took longer days in cool regimes, than in the delayed sowing in chickpea genotype (Clarke, 2001and Kiran, 2014). Temperature during sowing time from early to late and extra late directly related to vegetative and reproductive seasons. Sowing very much favorable for vegetative growth during mid and end of November as well as least stress on the reproductive phase because temperature did not change drastically, but several affected by growth of chickpea crop and grain filling time in December and January and genotype response also showed variations with different temperatures on pollen fertility and stigma sensitivity during reproductive period. For these reasons, the present investigation was carried out to assessed the PCV, GCV, heritability, genetics advance of physiological traits on chickpea in three different environments.

MATERIAL AND METHOD

Twenty-five chickpea genotypes were grown in three environments (Normal 28 Nov. mid-late 28 Dec. and very- late 28 Jan.2020) during Rabi season 2019-20 under all India coordinated research project in chickpea in the experiment field of RAK College of Agriculture, Sehore (M.P.). The observations were identified on nine physiological traits such as leaf area (cm^2) at 45 Days after sowing and 60 DAS, leaf area index (LAI) at 45 Days after sowing & 60 DAS, total dry matter (g) per plant at 45 Days after sowing & 60 DAS, net assimilation rate ($g/cm^2/day$), crop growth rate ($g/m^2/day$), chlorophyll index (SPAD) each of the three environments these were estimated from five randomly selected plants. The genotypes were organized in randomized complete block design with two replications. Data were subjected to statistical analysis to work out genotypic (GCV) and phenotypic (PCV) coefficients of variation, heritability and genetic advance as per cent of mean as per standard methods. Standard statistical procedure were used for the analysis of variance **(**Fisher, 1918), genotypic and phenotypic coefficients of variation (Burton, 1952), genetic advance (Johnson *et al.*, 1955).

RESULTS

The present investigation aimed to assess genotype variability (GCV, PCV, Heritability, Genetic advance) of physiological characters on chickpea in three environments (normal, mid-late, very-late), respectively. The analysis of variance for nine physiological characters of twenty-five chickpea genotypes derived from three environments and evaluated under normal, mid-late, very-late sown conditions are shown in (Table -1). The mean sum of squares due to various sources of variation for physiological characters revealed that all three environments obtained significant differences, indicating that the variability among the selected genotypes was significant.

Phenotypic Coefficient Variation and Genotypic Coefficient Variation:

The estimate of PCV were higher than an estimate of GCV for all most the traits, that suggested the apparent variation is not only due to genotypes but also due to the influence of environment.The estimations of the genetic variability parameters for various physiological traits are shown in (Table-2).

LA&LAI at 45 DAS and 60 DAS:

The leaf area & leaf area index expresses the functional scale of the crop stand assimilation apparatus and has been used as the primary value for the measurement of other growth determinants (Watson, 1947 and 1952). Significant variations were found in LA & LAI at 45 and 60 DAS due to different climatic conditions. A progressive pattern of LA & LAI increase was observed under normal growing condition. The highest PCV were recorded for leaf area at 45 DAS (29.68%, 44.41%, 35.69%) & 60 DAS (41.36%, 31.29%, 33.42%), LAI at 45 DAS (29.65%, 44.37%, 35.59%) & 60 DAS (41.35%, 31.28%, 33.44%),as well as The highest GCV were noted for leaf area at 45 DAS (29.51%, 44.33%, 34.88%) & 60 DAS (41.34%, 31.28%, 33.24%), LAI at 45 DAS (29.47%, 44.28%, 34.75%) & 60 DAS (41.32%, 31.26%, 33.26%).

TDM at 45 DAS and 60 DAS:

The present investigation indicated that the total dry matter at 45 DAS and 60 DAS significant variances were found due to heat stress plant growth was reduced in heat stress conditions. The highest PCV showed for total dry matter at 45 DAS (35.15%, 36.67%, 26.23%) Whereas, it was also highest for total dry matter at 60 DAS in E-I (35.13%) & E-II (31.81%). Medium PCV was noted for total dry matter at 60 DAS (19.25%) in E-III as well as highest GCV were recorded for total dry matter at 45 DAS (34.66%, 36.51%, 26.11%) in all three environments (E-I, E-II, E-III) and also total dry matter at 60 DAS in E-I (34.99%) & E-II (31.75%) recorded highest values. Whereas, the medium GCV was noted for total dry matter at 60 DAS (19.21%) in E-III.

NAR and CGR:

High estimates of PCV were observed for NAR and CGR. Similar trend was identified at genotypic level also. Thus, the present investigation revealed that the existence of sufficient genetic variability in the population and there is a lot of scope for achieving desirable improvement. The difference between phenotypic coefficient of variation and genotypic coefficient of variation was high for these traits. This suggests that the expression of these traits was least affected by the environmental factors and their phenotype is the true representative of its genotype. Further, the selection on the basis of per cent performance will be effective. In normal date of sowing NAR ranged 0.006032 to 0.066939 ($g/cm^2/day$) and in late sowing ranged 0.002621 to 0.0124 ($g/cm^2/day$) and also the CGR ranged in E-I normal sown conditions was 8.93 to 36.24 ($g/m^2/day$) and 3.51 to 16.2 ($g/m^2/day$) in late sowing ranged. The highest PCV were recorded for NAR (79.5%, 26.61%, 42.65%), CGR (38.96%, 36.13%, 29.41%) in all environmental conditions (E-I, E-II, E-III) as well as the highest GCV were reported NAR (78.73%, 26.25%, 41.11%), CGR (38.69%, 36%, 29.29%) in all three environments (E-I, E-II, E-III).

Chlorophyll index:

Heat stress can also cause damage to photosynthetic apparatus such as increased photo oxidation of chlorophyll and inhibition of chlorophyll biosynthesis and damage in lamellar membrane of chloroplast. The chlorophyll index was reduced when temperature get increased due to high temperature synthesis of chlorophyll was negatively affected which resulted chlorophyll index and photosynthesis rate reduction in high temperature conditions. In normal date (E-I) of sowing chlorophyll index ranged was 20.23 to 67.26 in E-I, 23.41 to 74.05 in E-II and 18.32 to 53.13 SPAD in late date (E-III) of sowing. Reduction of mean value from E-II to E-III was 15.89 SPAD due to high temperature. The highest PCV were recorded for chlorophyll index (30.26%, 26.94%, 25.27%) in all environmental conditions (E-I, E-II, E-III) as well as the highest GCV were showed chlorophyll index (29.53%, 26.22%, 22.97%) in all three environments (E-I, E-II, E-III).

Heritability:

Heritability estimated in broad sense, is the ratio of genotypic variance to the phenotypic variance and is expressed in percentage. It is an index of transmission of a character from parents to their offspring. It helps the plant breeders in the selection of superior genotypes from the genetically variable population. Robinson *et al. (*1949) has classified heritability estimate in broad sense as high (above 60%), medium (30-60%), and low (below 30%).The high heritability were observed for LA at 45 DAS (99.22%, 99.61%, 93.87%) & 60 DAS (99.87%, 99.88%, 98.91%), LAI at 45 DAS (99.18%, 99.6%, 93.64%) & 60 DAS (99.86%, 99.89%, 98.92%), TDM at 45DAS (97.21%, 9.13%, 99.05%) & 60 DAS (99.2%, 99.59%, 99.55%), NAR (98.06%, 97.24%, 92.9%), CGR (98.62%, 99.28%, 99.18%), chlorophyll index (SPAD) (95.23%, 94.72%, 82.59%) in normal, late and very late sowing conditions. The high heritability was also observed for all physiological parameters in normal late and very late planting conditions, as well as the collection of genotypes for these traits could be useful in the above-mentioned environments. As a result, most of the characters were highly heritable and less influenced by the environment.

Genetic advance as % of mean:

Expected genetic advance as percent of mean is the product of selection intensity, heritability and phenotypic standard deviation. Heritability in conjunction with genetic advance would give a more reliable index for selection. More genetic advance could be expected from a population with wide variability, and high heritability estimates. The genetic advance (GA) for physiological traits as per mean in per cent was reported in Tables II. The high Genetic advance as per mean was observed for LA at 45 DAS (73.17%, 91.15%, 60.49%) & 60 DAS (85.11%, 64.40%, 68.11%), LAI at 45 DAS (73.12%, 91.06%, 60.07 %) & 60 DAS (85.07%, 64.37%, 68.15%), TDM at 45DAS (70.40%, 74.89%, 53.54%) & 60 DAS (71.79%, 65.27%, 39.49%), NAR (160.61%, 53.33%, 81.64%), CGR (79.16%, 73.90%, 60.10%), chlorophyll index (SPAD) (59.37%, 52.58%, 43.00%) in E-I, E-II & E-III planting condition scan be used for selecting higher yielding genotypes.

CONCLUSION

To present study, the nine physiological traits were observed that significantly superior in E-I followed by E-II sowing conditions. the physiological traits were identified such as total dry matter at 60 DAS, CGR and chlorophyll index were best performed in E-I planting conditions while, LA & LAI at 45 & 60 DAS, total dry matter at 45 DAS were in E-II. The total dry matter was recorded least affected in E-I, E-II, E-III sowing conditions and chlorophyll index was the high affected in three planting conditions.

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Table-1 Analysis of variance for physiological characters in chickpea genotypes over three environmental conditions

Source of variations	ENV	d.f	LA at 45 DAS	LA at 60 DAS	LAI at 45 DAS	LAI at 60 DAS	TDM at 45 DAS	TDM at 60 DAS	NAR	CGR	Chlorophyll Index
Replications	**E1**	**1**	526.46	600.88	0.006	0.006	0.001	0.031	$3.49x10^{-6}$	0.11	0.03
	E2	**1**	86.06	84.68	0.001	0.001	0.036	0.29	$4.21x10^{-5}$	0.62	7.43
	E3	**1**	541.75	1194.98	0.007	0.013	0.147	0.153	$1.88x10^{-7}$	0.001	0.02
Genotypes	**E1**	**24**	5308.01**	72025.2**	0.059**	0.79**	2.22*	34.56**	$3.37x10^{-4}$**	116.28**	293.1**
	E2	**24**	28808.09**	14393.22**	0.32**	0.32**	2.15*	24.94**	$9.53x10^{-3}$**	88.04**	329.26**
	E3	**24**	7483.98**	46262.22**	0.083**	0.515**	0.697	3.14**	$1.39x10^{-5}$**	15.47**	122.22**
Error	**E1**	**24**	30.74	44.24	0.00	0.001	0.031	0.13	$3.28x10^{-6}$	0.80	7.15
	E2	**24**	55.25	80.34	0.001	0.001	0.009	0.05	$1.33x10^{-4}$	0.31	8.92
	E3	**24**	173.04	252.1	0.002	0.003	0.003	0.007	$5.12x10^{-7}$	0.063	11.65

Table-2 Genetic parameters of variation for physiological traits over three environmental conditions

Characters	ENV.	MEAN	RANGE		h^2 (bs) (%)	GCA (%)	PCA (%)	Genetic advance	GA as % of mean
			Max.	Min.					
LA at 45 DAS	**E-I**	180.24	371.34	90.06	99.22	35.66	35.80	131.90	73.17
	E-II	270.47	527.87	116.10	99.61	44.33	44.41	246.52	91.15
	E-III	170.31	290.82	82.55	93.87	30.31	31.28	103.02	60.49
LA at 60 DAS	**E-I**	458.88	1027.17	193.50	99.87	41.34	41.36	390.56	85.11
	E-II	856.97	1321.76	382.43	99.88	31.28	31.29	551.90	64.40
	E-III	456.27	804.27	161.06	98.91	33.24	33.42	310.75	68.11
LAI at 45 DAS	**E-I**	0.60	1.23	0.30	99.18	35.64	35.78	0.43	73.12
	E-II	0.90	1.75	0.38	99.6	44.28	44.37	0.82	91.06
	E-III	0.57	0.96	0.27	93.64	30.13	31.14	0.34	60.07
LAI at 60 DAS	**E-I**	1.52	3.42	0.64	99.86	41.32	41.35	1.30	85.07
	E-II	2.85	4.40	1.27	99.89	31.26	31.28	1.84	64.37
	E-III	1.52	2.68	0.53	98.92	33.26	33.44	1.04	68.15
TDM at 45 DAS	**E-I**	3.01	4.91	1.08	97.21	34.66	35.15	2.12	70.40
	E-II	2.83	4.72	1.05	99.13	36.51	36.67	2.12	74.89
	E-III	2.25	3.61	1.07	99.05	26.11	26.23	1.21	53.54
TDM at 60 DAS	**E-I**	11.85	20.18	5.77	99.2	34.99	35.13	8.51	71.79
	E-II	11.11	18.92	4.96	99.59	31.75	31.81	7.25	65.27
	E-III	6.51	9.32	4.02	99.55	19.21	19.25	2.57	39.49

NAR	**E-I**	0.01641	0.06694	0.006032	98.06	78.73	79.5	0.03	160.61
	E-II	0.261225	0.40538	0.104167	97.24	26.25	26.61	0.14	53.33
	E-III	0.006301	0.0124	0.002621	92.9	41.11	42.65	0.01	81.64
CGR	**E-I**	19.63	36.24	8.93	98.62	38.69	38.96	15.54	79.16
	E-II	18.39	33.53	7.60	99.28	36	36.13	13.59	73.90
	E-III	9.47	16.2	3.51	99.18	29.29	29.41	5.69	60.10
Chlorophyll index (SPAD)	**E-I**	**40.48**	**67.26**	**20.23**	**95.23**	**29.53**	**30.26**	**24.03**	**59.37**
	E-II	**48.25**	**74.05**	**23.41**	**94.72**	**26.22**	**26.94**	25.37	52.58
	E-III	**32.36**	**53.13**	**18.32**	**82.59**	**22.97**	**25.27**	13.92	43.00