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Estimation of genetic variability for *Kabuli* chickpea (*Cicer arietinum* L.) under timely and late sowing condition

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Abstract
Fifty diverse *Kabuli* chickpea genotypes sown under timely and late sowing conditions (D_0 & D_1) during *rabi* season of 2016-17. Analysis of variance revealed that significant differences among the genotypes for all the characters under different sowing condition *viz*, timely (D_0) and late (D_1). High PCV and GCV were accounted for the traits number of primary branches per plant, seed yield per plant and 100-seed weight under timely and late sowing condition. The values of phenotypic coefficient of variation in both sowing conditions (D_0 & D_1) were higher than that of genotypic coefficient of variation for all the traits studied, indicating more influence of environment on the expression of these characters. Number of primary branches per plant, number of secondary branches per plant, plant height, reproductive phase duration, days to 50 per cent flowering, number of pods per plant, seed yield per plant and 100-seed weight noted for high heritability along with high genetic advance as percentage of mean. The high heritability values indicated that heritability may be due to higher contribution of genotypic component in these traits.

Keywords: genetic variability, heritability, genetic advance, *Kabuli* chickpea

Introduction
Chickpea (*Cicer arietinum* L.) belongs to genus *Cicer*, tribe *Cicereae*, family *Fabaceae* and sub family *Papilionaceae*, (Bentham and Hooker, 1972). It is a self-pollinated diploid (2n=2x=16). In India, the area under chickpea was 8.39 million hectares with a production of 7.06 Million tones and productivity of 840 kg/ha during *Rabi* 2015-16. In Gujarat, area under chickpea was 1.15 lakh hectares with a total production of 1.53 lakh tones and productivity of 1330 kg/ha during 2015-16 (Anonymous, 2017) [1]. Yield being a complex character. It is the result of action and interaction of many yield contributing characters and it is highly influenced by environment. Hence, it becomes necessary to partition the observed variability into heritable and non-heritable components. The genetic variability is determined with the help of certain genetic parameters *viz*., genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV). Heritability is the heritable portion of phenotypic variation and it is a good index of transmission of a character from one generation to another generation. If the heritability of a character is high, the phenotypic value provides a fairly close measure of the genotypic value and thus, breeders can base his selection on the phenotypic performance, thereby the knowledge of heritability helps the plant breeder in pre-assessing the results of selection for a particular character. The knowledge of heritability coupled with expected genetic advance for a trait will help us in deciding the scope of improvement of that particular trait through selection. Therefore, the study was conducted to estimate genetic variability, heritability and genetic advance in 50 diverse *kabuli* chickpea genotypes under timely and late sowing conditions for utilization in selection programmes aimed at productivity increase of future genotypes.

Materials and Methods
The experiment was carried out at the Pulses Research Station, Junagadh Agricultural University, Junagadh during *Rabi* 2016-17. The pure seeds of genotypes were obtained from the Pulses Research Station, Junagadh Agricultural University, Junagadh. Fifty genotypes of chickpea were sown, first on timely sowing condition 16th November, 2016 (D_0) and second on late sowing condition 10th December, 2016 (D_1) in a randomized block design with three replications. Each line was sown in a single row plot of 4.0 m length with a spacing of 45 X 10 cm. The genotypes were randomly allotted to the plots in each replication. All the recommended agronomical practices along with necessary plant protection measures were Followed timely for the successful raising of crop. The observations were recorded on

these five randomly selected plants in each line and in each replication for 10 quantitative characters *viz.*, Days to 50 per cent flowering (Days), Days to maturity (Days), Reproductive Phase duration (Days), Plant height (cm), Number of primary branches per plant, Number of secondary branches per plant, Number of pods per plant, Number of seeds per pod, 100-seed weight (g) and Seed yield per plant (g) and their mean values were used for statistical analysis. Analysis of variance was carried out as per methodology given by Panse and Sukhatme (1985) [10]. Genotypic and phenotypic coefficients of variation (GCV and PCV) were calculated by the formula given by Burton and De Vane (1953), heritability in broad sense (h^2) and genetic advance was estimated formula given by Johnson *et al*. (1955) [8].

Results and Discussion

Analysis of variance (Table 1 & 2) revealed that significant differences among the genotypes for all the characters under different dates of sowing *viz*, timely (D_0) and late (D_1). This suggested that the genotypes selected for research were quite variable and considerable amount of variability existed among them. Hence, it provides ample scope for selection of different quantitative and qualitative characters for yield improvement in chickpea. Similar results were reported by Dhameliya *et al.* (2008) [5].

The estimate of genotypic and phenotypic coefficient of variability (Table 3) indicate that the values of phenotypic coefficient of variation were higher than genotypic coefficient of variation for both sowing dates, in most of the cases, indicating more influence of environmental factors. Similar results were also reported by Singh (2006) [15], Saki *et al*., (2009) [13] and Borate *et al*., (2010) [3]. These findings suggested that selection can be effective on the basis of phenotype along with equal probability of genotypic values.

The highest genotypic coefficient of variation and phenotypic coefficient of variation for both of the sowing condition was observed for seed yield per plant, number of primary branches per plant and 100-seed weight. The high genotypic coefficient of variation indicated the presence of wide variation for the characters under study to allow selection for individual traits. High genotypic and phenotypic coefficient of variation was reported in chickpea for these traits by Nimbalkar, 2000; Patel, 2005; Vaghela *et. al*., 2009; Borate *et al.,* 2010; Jadhav *et al.,* 2012; Hussain *et al.,* 2016 and Roy *et al.,* 2016.

With the help of genotypic coefficient of variation alone, it is not possible to determine the extent of variation which is heritable. Thus, the knowledge of heritability of a character helps the plant breeder in predicting the genetic advance for any quantitative characters and aids in exercising necessary selection procedure. Burton (1952) [4] suggested that genotypic coefficient of variation together with heritability estimate would give the best picture expected for selection.

The maximum heritability (Table 3) was observed for 100-seed weight, number of secondary branches per plant, number of primary branches per plant, days to 50 per cent flowering, number of seeds per pod, days to maturity, plant height, number of pods per plant, seed yield per plant and reproductive phase duration. The characters expressing higher heritability estimates are less influenced by environment and such characters have also indicated that they are under influence of more number of fixable factors. These results are akin with the findings of Patel (2005) [11], Singh (2006) [15] and Vaghela *et al*., (2009) [16].

The maximum genetic advance as per cent of mean (Table 3) under both sowing conditions was observed for number of primary branches per plant, 100-seed weight, seed yield per plant, number of secondary branches per plant, number of pods per plant, plant height, reproductive phase duration and days to 50 per cent flowering, which illustrated that they could be improved to a large extent. Patel (2005) [11] and Vaghela *et al.,* (2009) [16] also reported the similar results of high value of genetic advance for number of pods per plant and seed yield per plant.

Johnson *et al.,* (1955) [8] suggested that the heritability estimate along with genetic advance is more useful than the heritability alone in predicting the resultant effect of selection. In the present study, the estimates of high heritability coupled with high genetic advance as per cent of mean was observed for number of primary branches per plant, 100-seed weight, seed yield per plant, number of secondary branches per plant, number of pods per plant, plant height, reproductive phase duration and days to 50 per cent flowering which may be contributed to the preponderance of additive gene action and selection pressure could profitably be applied on these characters for improving the seed yield.

Table 1: Analysis of variance showing mean squares for various characters in 50 genotypes of chickpea under timely sowing condition (D_0)

Characters	Mean sum of squares		
	Replication (d.f.= 2)	Genotypes (d.f.= 49)	Errors (d.f.= 98)
Seed yield per plant (g)	13.01	73.76**	9.51
Days to 50% flowering	0.24	147.81**	7.35
Days to maturity	53.34	275.44**	21.62
Reproductive phase duration	60.66	152.07**	26.45
Plant height (cm)	9.92	141.14**	11.93
No. of primary branches per plant	0.06	0.86**	0.03
No. of secondary branches per plant	0.42**	2.71**	0.06
No. of pods per plant	22.93	244.16**	24.52
No. of seeds per pod	0.01	0.03**	0.01
100-seed weight (g)	0.34	115.34**	0.84

** Significant at 5% and 1% levels, respectively

Table 2: Analysis of variance showing mean squares for various characters in 50 genotypes of chickpea under timely sowing condition (D_1)

Characters	Mean sum of squares		
	Replication (d.f.= 2)	Genotypes (d.f.= 49)	Errors (d.f.= 98)
Seed yield per plant (g)	2.05	53.95**	5.90
Days to 50% flowering	4.49	154.80**	6.35
Days to maturity	19.13	260.33**	11.38
Reproductive phase duration	5.54	155.59**	13.37

Plant height (cm)	34.21	142.51**	11.14
No. of primary branches per plant	0.14	0.77**	0.05
No. of secondary branches per plant	0.46**	2.54**	0.08
No. of pods per plant	24.16	217.92**	17.69
No. of seeds per pod	0.01	0.02**	0.01
100-seed weight (g)	0.29	115.34**	0.95

*,** Significant at 5% and 1% levels, respectively

Table 3: Phenotypic and genotypic coefficient of variation, heritability, genetic advance and genetic advance expressed as per cent of mean for various characters in chickpea under both timely sowing (D_0) and late sowing (D_1)

Characters	Phenotypic coefficient of variation (%)	Genotypic coefficient of variation (%)	Heritability in broad sense (%)	Genetic advance	Genetic advance expressed as percent of mean
Timely sowing (D_0)					
Seed yield per plant (g)	29.63	24.66	69.26	7.93	42.27
Days to 50% flowering	11.79	10.96	86.43	13.10	21.00
Days to maturity	9.72	8.68	79.65	16.91	15.95
Reproductive phase duration	18.96	14.84	61.29	10.43	23.94
Plant height (cm)	15.75	13.93	78.30	11.96	25.40
No. of primary branches per plant	26.67	25.18	89.20	1.02	49.00
No. of secondary branches per plant	14.73	14.22	93.16	1.86	28.28
No. of pods per plant	17.06	14.77	74.91	15.25	26.33
No. of seeds per pod	8.51	7.86	85.21	0.17	14.94
100-seed weight (g)	22.42	22.18	97.86	12.58	45.20
Late sowing (D_1)					
Seed yield per plant (g)	29.78	25.46	73.08	7.04	44.84
Days to 50% flowering	12.70	11.96	88.63	13.64	23.19
Days to maturity	9.87	9.26	87.94	17.59	17.89
Reproductive phase duration	19.72	17.42	78.00	12.52	31.69
Plant height (cm)	15.75	14.06	79.72	12.17	25.87
No. of primary branches per plant	25.80	23.67	84.17	0.93	44.75
No. of secondary branches per plant	14.40	13.77	91.37	1.78	27.11
No. of pods per plant	18.63	16.57	79.05	14.96	30.34
No. of seeds per pod	7.73	7.06	83.43	0.15	13.29
100-seed weight (g)	22.52	22.25	97.58	12.56	45.28

Conclusion

It can be concluded from the present study that seed yield per plant, number of primary branches per plant, and 100-seed weight exhibited high magnitude of genetic advance expressed as percentage of mean coupled with high heritability values and greater genotypic and phenotypic coefficient of variations. It indicates that additive gene action was operating for these characters. Therefore, the phenotypic selection for these traits would be most effective.

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