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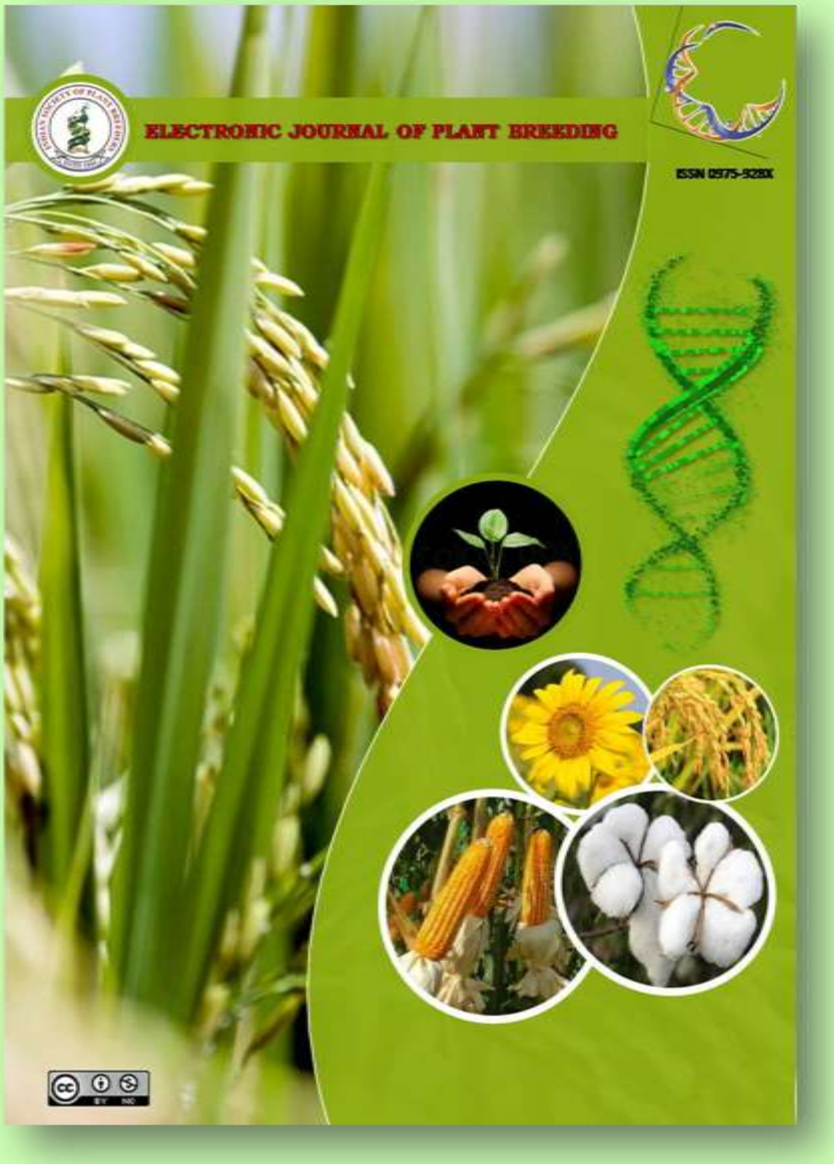

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Research Article

Genetic variability for morphological and biometrical traits in chickpea (*Cicer arietinum* L.)

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Abstract
An experiment was conducted to assess the genetic variability for quantitative and qualitative traits in 52 *desi* chickpea genotypes. The significant variation was observed for all the traits. High phenotypic and genotypic coefficient of variation was observed for single plant yield followed by hundred seed weight, number of secondary branches, number of pods per plant, number of seeds per plant and first pod height. High heritability along with a high estimate of genetic advance expressed as per cent of mean was exhibited for single plant yield, hundred seed weight, number of secondary branches, number of pods per plant, number of seeds per plant and first pod height. Cluster analysis based on eight qualitative characters grouped all 52 genotypes into eight major clusters at 0.48 similarity coefficient value. Cluster I was found to be the largest one with 16 genotypes while, cluster VI and VIII were the smallest one with single genotype each (CB PLS 5433 and CB RC 110-2). A marked difference was observed between the genotypes for the qualitative traits indicating the importance of such traits in germplasm characterization.

Key words
Chickpea *desi* germplasm, genetic variability, quantitative and qualitative traits

Introduction

Pulses are an overriding source in the human diet all over the world. Chickpea (*Cicer arietinum* L.), is one of the foremost grain legume crops domesticated and cultivated by man and widely believed to be descended from South Eastern Turkey and the adjoining part of Syria dated to the eighth millennium BC. Chickpea also called as gram or Bengalgram, a self-pollinated species with 2n = 2X = 16 chromosomes, is the third most important pulse crop in the world and first in India. It is grown in arid and semi-arid regions of the world with a total annual production of 12.09 million tonnes from l2.65 million hectares (FAOSTAT, 20l8). India is a premier chickpea growing country covering about 60 per cent of the world area and production. In India, the production stands at 7.81 million tonnes from 8.39 million hectares (FAOSTAT, 20l8).

The major constraints in achieving higher yield of this crop was due to lack of genetic diversity in cultivated chickpea, biotic stresses such as pod borer, Fusarium wilt, and Ascochyta blight and abiotic stresses such as drought, heat, cold and salinity. Improvement in yield and quality of the crop in both suitable and adverse environment is the foremost aim of a plant breeder. Basis of any crop improvement programme involves selection of elite genotypes with superior characters. The efficiency of selection depends largely on the conservation and use of the world's plant genetic resources. Evaluation of genetic variability in the base population is necessary for the usage of the genetic resource. Thus knowledge of genetic variability, heritability, and genetic advance as per cent of mean is essential to choose better genotypes for crop improvement. A better understanding of genetic diversity in the available chickpea germplasm would help in the selection of promising lines for crop breeding programmes.

Materials and Methods

Fifty-two *desi* genotypes of chickpea were evaluated during *Rabi* season of 2018-2019 at Department of Pulses, Centre for Plant Breeding and Genetics, Tamil Nadu Agricultural University, Coimbatore. The experiment was laid out in randomized complete block design with two replications. Each accession was sown in a single row of four-meter length with a spacing of 30 x 10 cm. All the recommended agronomic practices were carried out during the crop growth period. The observations were recorded for 10 quantitative characters *viz.,* days to 50 per cent flowering, first pod height (cm), days to maturity, plant height (cm), number of primary branches, number of secondary branches, number of pods per plant, number of seeds per plant, hundred seed weight (g) and single plant yield (g) on three randomly selected plants. Eight qualitative characters *viz.*, growth habit, plant pigmentation, leaf type, flower color, plant pubescence, seed color, seed shape and testa texture were also recorded in each accession based on descriptors for chickpea.

Statistical parameters such as mean and variance were carried out by adopting the standard methods of analysis by Panse and Sukhatme (1964). The phenotypic and genotypic variability for each of the characters was estimated by using the method given by Burton (1952), heritability (h^2) in the broad sense according to Lush (1940) and the genetic advance as per cent of mean was worked out based on the method given by Johnson *et al.*, (1955). Cluster analysis was carried out using Simple Matching coefficient and dendrogram was constructed for the variability in qualitative characters, based on the UPGMA method by NTSYS pc 2.02 software.

Results and Discussion

In the present study, analysis of variance revealed that there were highly significant differences between genotypes for all the characters indicating the presence of genetic variability among the genotypes. It is of great interest to consider the per se performance of different genotypes in quantitative characters of economic view particularly earliness, primary and secondary branches per plant, pods per plant, 100 seed weight and grain yield. The genotypes *viz.*, CO 3, CB 5697, CB PLS 5241, CB PLS 5225, CB ICC 4945, CB PLS 5219-1, CB 16905 and CB GC 9107 were found to be the earlier to flower (39 days) whereas CB PLS 5433 (65 days) was late to flower. Mean value for 50% flowering was recorded as 47 days. The days to maturity ranged from 99 (CB PLS 5433 and CB 89339) to 71 days (CB ICC 4945) with a mean value of 85 days. The plant height recorded the mean value of 31.03 cm and it ranged from 23.17 (CB PLS 5219-1) to 44.33 cm (CB PLS 5487). The genotypes CB RC 110-2 and CB 4951-1 had the highest number of primary and secondary branches (5.83 and 9.17) with a mean value of 2.65 and 5.47, respectively. The number of pods per plant recorded the mean value of 52.37 and it ranged from 14.92 (CB PLS 5433) to 86.00 (CB 11502). The 100 seed weight ranged from 9.25 (CB 89223) to 36.98 g (CB 5697) with a mean value of 22.21 g. The single plant yield was recorded high for CB 11502 (28.65 g) and low for CB PLS 5433 (4.06 g).

The genetic parameters *viz.*, PCV, GCV, heritability and GAM are of greater importance in the study of the extent of genetic variability among the genotypes. In breeding, the potential of any experimental material depends on the amount of genetic variability present in the base population. The magnitude of phenotypic coefficient of variation (PCV) was slightly higher than their corresponding genotypic coefficient of variation (GCV) for all the characters indicating the minimum influence of environment in the expression of traits. The highest amount of GCV was exhibited by single plant yield (32.50 per cent) followed by hundred seed weight (30.74 per cent). The other traits *viz.*, number of secondary branches, number of pods per plant, number of seeds per plant and first pod height also recorded high GCV. The moderate GCV value was exhibited by plant height, days to 50 per cent flowering and number of primary branches while days to maturity (6.45 per cent) possessed low magnitude of GCV. A high amount of GCV for pods per plant was reported by Akhtar *et al.* (2011), Hussain *et al.* (2017) and Sohail *et al.* (2018); for seed yield per plant by Akhtar *et al.* (2011) and Hussain *et al.* (2017) in chickpea. The broad sense heritability ranged from 56.97 (number of primary branches) to 96.20 per cent (hundred seed weight). Very high estimates of heritability were observed for all the characters except for number of primary branches (56.97 per cent). It might be due to the fact that the experiment was conducted only at a single location and for one year. The genetic advance as per cent of mean was high for characters *viz.*, single plant yield (63.97), hundred seed weight (62.11), number of secondary branches (48.28), number of pods per plant (47.48), number of seeds per plant (45.31), first pod height (42.55), plant height (30.74) and days to 50% flowering (27.40). High magnitude of genetic advance as per cent of mean for single plant yield and 100 seed weight was also reported by Bala *et al.* (2015) and Mohamed *et al.* (2015) and for pods per plant and the number of secondary branches by Sohail *et al.* (2018). Single plant yield, hundred seed weight, number of secondary branches, number of pods per plant, number of seeds per plant and first pod height showed high heritability along with higher to moderate GCV and higher genetic advance as per cent of mean (Fig. 1) as already reported by Hussain *et al.* (2017) and Sohail *et al.* (2018). High heritability coupled with high estimate of genetic advance as per cent of mean and GCV indicate that most likely the heritability was due to additive gene effects and the genotypes under study were highly diverse and of great genetic potential with regard to these characters.

Out of the eight qualitative characters studied, six traits *viz.*, growth habit, plant pigmentation, flower colour, seed colour, seed shape, and testa texture had difference among the genotypes (Table 2). Genotypes with semi-spreading growth habit, green pigmentation and pink flower colour were more frequent (Fig. 2). Spreading growth habit and green pigmentation were reported to be dominant over erect growth habit and purple pigmentation, respectively by Singh and Shyam (1959) and Rao *et al.* (1980). Reddy and Nayoem (1978) reported that pink colour of corolla was controlled by a pair of complementary genes. Among the seed traits, yellow colour seeds with rough seed coat and angular seed shape was found highly frequent in the genotypes.

The dendrogram generated using the eight qualitative characters data grouped all 52 genotypes into eight major clusters at 0.48 similarity coefficient value (Fig. 3). The value of 0.48 was set only for the convenience of explanation in this case. Cluster I was the largest cluster comprising 15 genotypes followed by cluster III (13), cluster VII (8), cluster II, III (5 each) and cluster V (4). Cluster VI and VIII were monogenotypic with genotype CB PLS 5433 and CB RC 110-2 exhibiting the distinctiveness among the germplasm. The dendrogram revealed five pairs of genotypes *viz.*, CB RC 7-2 and CB 5521, CB 5451 and CB RC 102-2, CB GC 9107 and CB 11502, CB PLS 5173 and CB ICC 4951, CB PLS 5734 and CB 86416 were found possessing 100% similarity among them indicating the possibility of duplication of the genotypes within the germplasm.

The results on the variability study revealed that traits *viz.*, single plant yield, hundred seed weight, number of secondary branches, number of pods per plant, number of seeds per plant and first pod height possessed high heritability coupled with a high estimate of genetic advance as per cent of mean and GCV indicating that these characters are controlled by additive gene effects and these traits will response to phenotypic selection. Considerable variation between the genotypes for qualitative characters indicates that such polymorphic characters can be used as a diagnostic descriptor for germplasm characterization, varietal identification and genetic studies.

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Table 1. Estimation of GCV, PCV, h^2 and GAM of ten quantitative characters of Chickpea

Characters	Mean	Range	PCV (%)	GCV (%)	h^2 (%)	GAM
Days to 50% flowering	47.00	39.00-65.00	14.50	13.89	91.70	27.39
First pod height (cm)	21.32	13.60-37.26	24.05	22.29	85.87	42.55
Days to maturity	85.00	71.00-99.00	7.07	6.45	83.13	12.11
Plant height (cm)	31.03	23.17-44.34	16.97	15.91	87.91	30.74
Number of primary branches	2.65	2.00-3.67	14.36	10.84	56.97	16.86
Number of secondary branches	5.47	2.84-9.17	27.21	25.25	86.14	48.28
Number of pods per plant	52.37	14.92-86.00	27.13	25.01	84.95	47.48
Number of seeds per plant	57.51	14.00-87.83	26.99	24.37	81.48	45.31
Hundred seed weight (g)	22.21	9.25-36.98	31.34	30.74	96.20	62.11
Single plant yield (g)	12.48	4.06-28.65	34.01	32.50	91.30	63.97

GCV-Genotypic coefficient of variation: PCV- Phenotypic coefficient of variation: h^2 -Heritability: GAM- Genetic advance as per cent of mean

Table 2. Frequency distribution of various qualitative traits of Chickpea

Qualitative characters			Number of accessions	Frequency (%)
Growth habit	1	Erect	0	0.00
	2	Semi-erect	16	30.77
	3	Semi- spreading	30	57.69
	4	Spreading	6	11.54
	5	Prostrate	0	0.00
Plant pigmentation	1	No anthocyanin, stems and leaves pale green	0	0.00
	3	No anthocyanin, stems and leaves green	26	50.00
	5	Low anthocyanin, stems and leaves partly light purple	23	44.23
	7	High anthocyanin, stems and leaves predominantly purple	3	5.77
	9	Highly purple	0	0.00
Flower colour	1	Blue	0	0.00
	2	Light blue	0	0.00
	3	Dark pink	23	44.23
	4	Pink	28	53.85
	5	Light pink	1	1.92
	6	White	0	0.00
	7	White-pink striped	0	0.00
Seed shape	1	Angular, ram’s head	49	94.23
	2	Irregular rounded, owl’s head	0	0.00
	3	Pea-shaped, smooth round	3	5.77
Seed colour	3	Light brown	4	7.69
	4	Dark brown	6	11.54
	7	Salmon brown	4	7.69
	10	Beige	9	17.31
	11	Yellow	11	21.15
	12	Light yellow	7	13.46
	13	Yellow brown	4	7.69
	14	Orange yellow	3	5.77
	16	Yellow beige	4	7.69
Testa texture	3	Rough	30	57.69
	5	Smooth	9	17.31
	7	Tuberculated	13	25.00

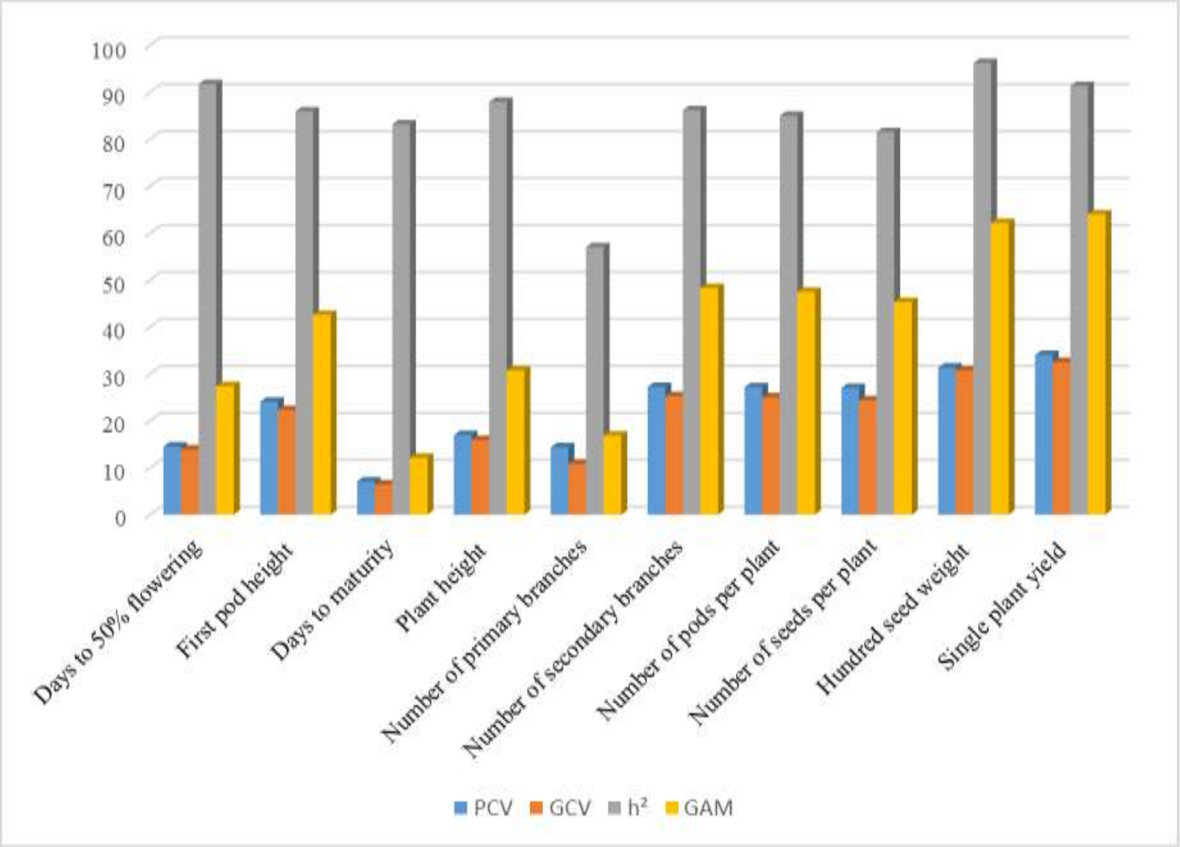

Fig. 1. Phenotypic Coefficient of Variation (PCV), Genotypic Coefficient of Variation (GCV), Heritability (h^2) and Genetic Advance as per cent of Mean (GAM) for quantitative characters in Chickpea

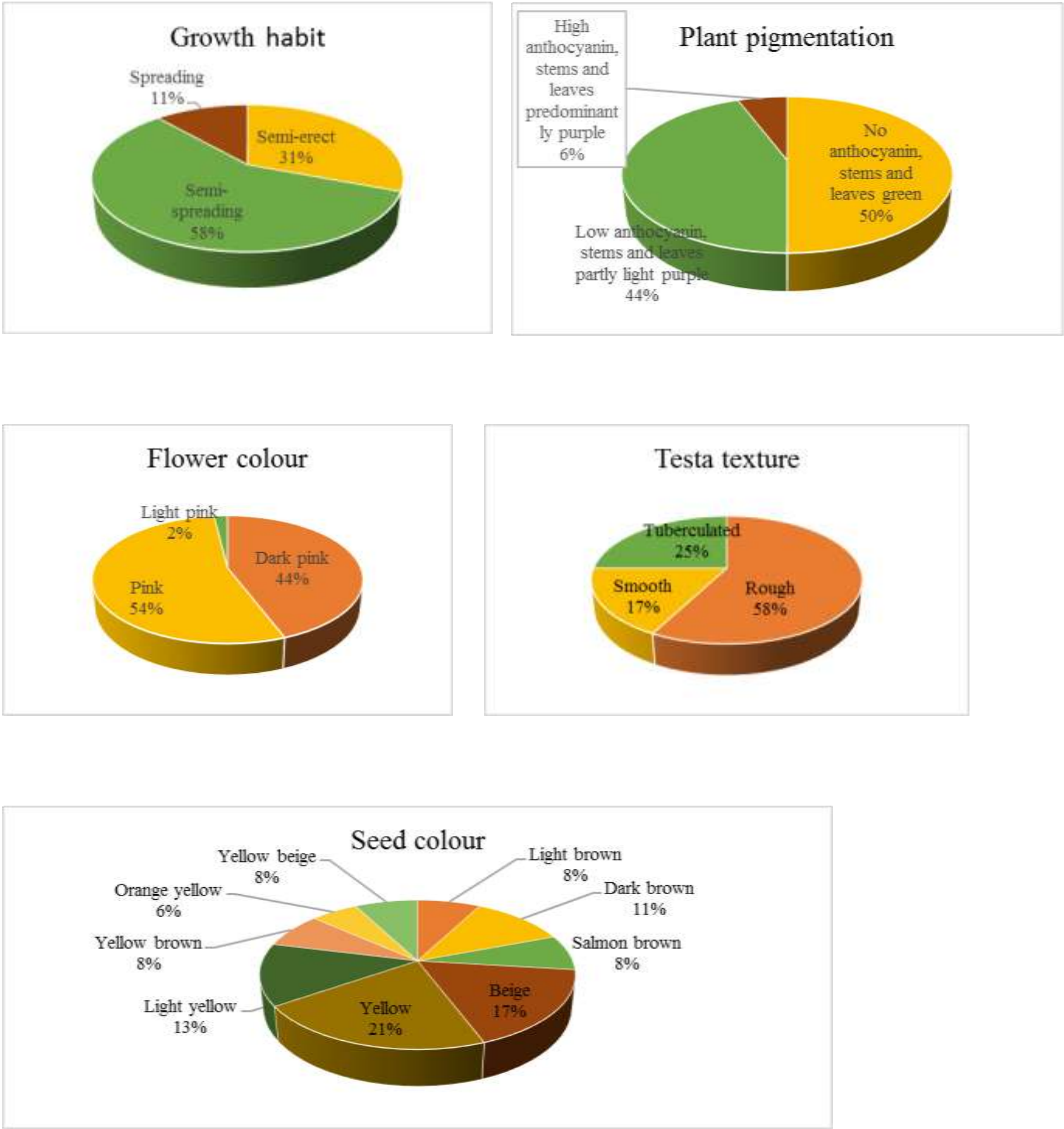

Fig. 2. Pie chart for the frequency distribution of various qualitative traits of Chickpea

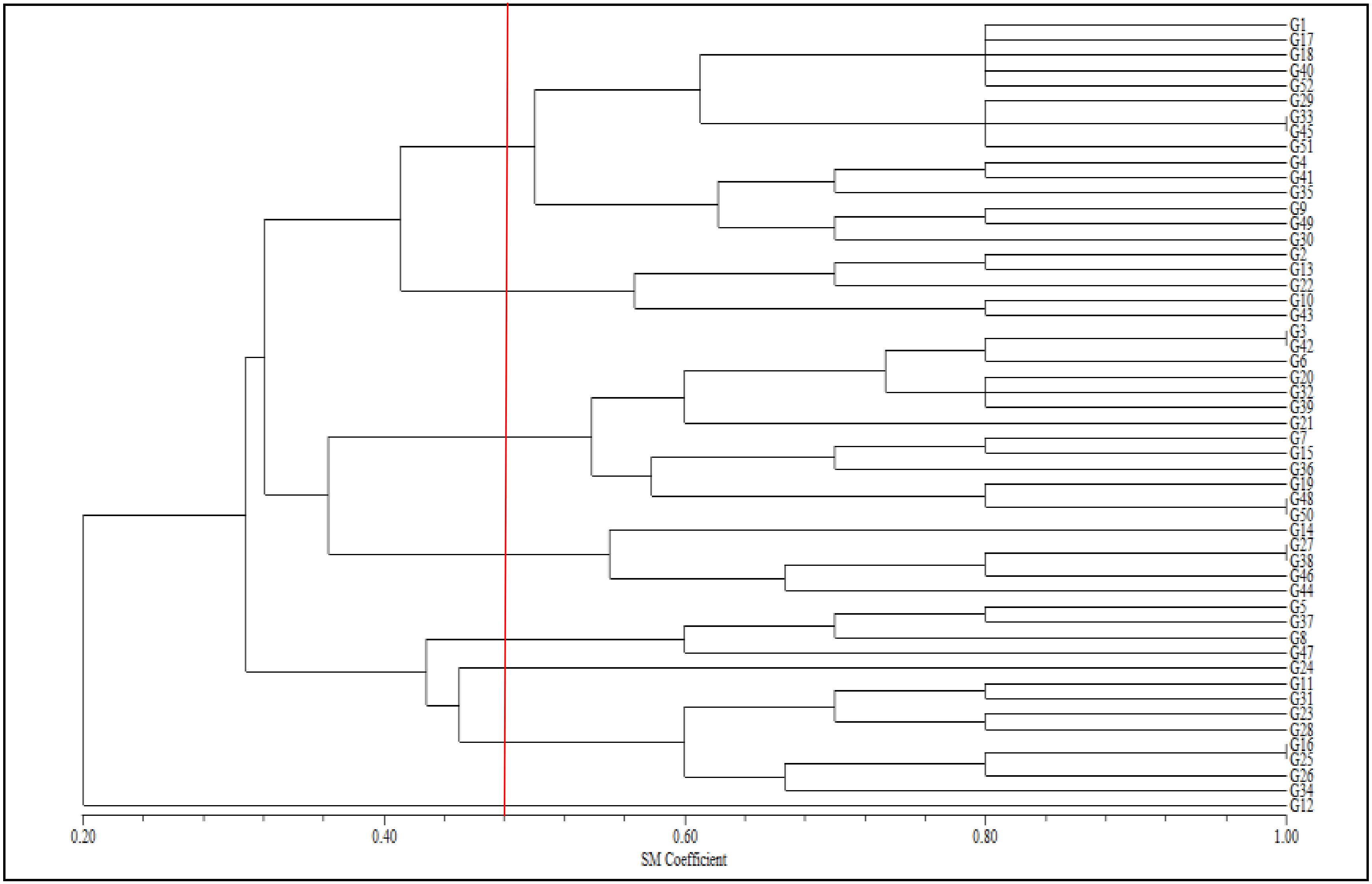

Fig. 3. Dendrogram generated from qualitative traits of 52 genotypes of Chickpea using UPGMA method

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