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Study of genetic variation among the genotypes of vegetable cowpea [*Vigna unguiculata* (L.) Walp.]

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Abstract
An investigation was carried out using 60 genotypes of vegetable cowpea to find out the correlation coefficients and path coefficients. The material was evaluated in a randomized block design with three replications at the Vegetable Research Station, J. A. U., Junagadh during summer 2018. The observations were recorded on 12 characters *viz*., days to 50% flowering, days to first green pod picking, number of primary branches per plant, plant height (cm), pod length (cm), pod width (cm), number of pods per plant, number of pods per cluster, ten pod weight (g), number of pods per plant, plant spread (cm) and green pod yield per plant (g). The values of genotypic correlations were higher than their corresponding phenotypic correlations. The pod yield per plant exhibited significant and positive correlations with number of primary branches per plant, plant height, pod length, number of pods per plant and number of seeds per pod at both genotypic and phenotypic levels. The path coefficient analysis showed the high positive direct influences on pod yield per plant through number of primary branches per plant and pod length and hence, due emphasis should be placed on these characters while selecting for high yielding types in vegetable cowpea.

Keywords: Variability, heritability, GCV, PCV, genetic advance, vegetable cowpea

Introduction
Cowpea [*Vigna unguiculata* (L.) Walp.] is an ancient crop probably domesticated during the Neolithic period. In India, it is commonly known as lubia, black eye, roungi, kaffir pea, china pea and southern bean. It is grown throughout the tropics and subtropics as a grain legume. Vegetables play a vital role in the health and nutritional security of human beings.

Their productivity per unit area is much higher than cereals. India ranked second in the production of vegetables with occupying 15.7% contribution in the world production (Anonymous, 2012) [3]. In India, the vegetable crops are grown in 102.59 lakh hectares with an annual production of 1843.94 lakh metric tonnes and the productivity of 17.97 tonnes/ha (Anonymous, 2018a) [4]. In Gujarat, it occupies an area of 6.50 lakh hectares with an annual production of 132.33 lakh metric tonnes and the productivity of 20.33 tonnes/ha (Anonymous, 2018b) [5]. In Gujarat, cowpea occupies an area of 27029 hectares with an annual production of 280818 metric tonnes and the productivity of 10.39 tonnes/ha (Anonymous, 2018b) [5]. Vegetable cowpea plays a key role in maintaining soil health and sustainability in the production from different cropping systems as they fix atmospheric nitrogen in their root nodules. Assessment of genetic variability in the base population is the first step in any breeding programme. The variability parameters certainly determine the extent and quality of variability. Genetic diversity plays a pivotal role in survival and adaptability of a species. When, a specific environment changes, slight genetic variation is necessary for it to adapt and survive. A species that has a large degree of genetic diversity among its population will have more variation.

Materials and Methods
The present investigation was carried-out to assess the genetic variability in 60 genotypes of cowpea. The experiment was laid-out in a Randomized Block Design with three replications at the Vegetable Research Station, Junagadh Agricultural University, Junagadh (Gujarat) during summer, 2018. The observations were recorded on five randomly selected plants in each entry and from each replication except days to 50% flowering, which was calculated on plot basis and their mean values were used for statistical analysis. The characters studied were days to 50% flowering, days to first green pod picking, number of primary branches per plant,

plant height (cm), pod length (cm), pod width (cm), number of pods per plant, number of pods per cluster, ten pod weight (g), number of pods per plant, plant spread (cm) and green pod yield per plant (g). Analysis of variance for randomized block design (RBD) was done as per Panse and Sukhatme (1985) [10]. Phenotypic co-efficient of variation (PCV) and genotypic co-efficient of variation (GCV) were calculated as per the formula suggested by Burton and De Vane (1953) [6]. Heritability and genetic advance were estimated using the formula suggested by Allard (1960) [1].

Results and Discussion

In the present study, analysis of variance revealed that mean squares due to genotypes were found significant for all the characters indicating the existence of sufficient genetic variability in the experimental material (Table 1). Experimental material showed wide range of phenotypic variation for green pod yield per plant (41.47%) followed by number of pods per plant (39.25%) and ten pod weight (20.55%). The estimates of genotypic (GCV) and phenotypic (PCV) coefficients of variation indicated that the values of PCV were higher than GCV due to interaction of the genotypes with the environment or other environmental factors influencing the expression of these characters. Narrow differences observed between the PCV and GCV in certain cases indicated that these characters were less influenced by the environments. Similar results were also obtained by Jogdhande *et al.* (2017) [7] and Anjali *et al.* (2018) [2] for green pod yield and its components. The high magnitude of GCV was observed for green pod yield per plant followed by number of pods per plant and ten pod weight. High magnitude of GCV indicated the presence of wide variation for the characters under studied to allow further improvement by selection of the individual trait. High estimates of GCV in cowpea have been also reported for green pod yield per plant and number of pods per plant by Jogdhande *et al.* (2017) [7] and Anjali *et al.* (2018) [2] and ten pod weight by Vavilapalli *et al*. (2013) [12] and Sapara *et al*. (2014) [11]. The genotypic coefficient of variation measures the amount of variation present in a particular character. However, it does not determine the proportion of heritable variation present in the total variation. Therefore, heritability which represents the heritable variation existing in the character was calculated. High values of heritability in broad sense are helpful in identifying the appropriate character for selection and in enabling the breeders to select superior genotypes on the basis of phenotypic expression of quantitative traits (Johnson *et al.*, 1955) [8]. The maximum heritability estimates were observed for number of pods per plant (98.53%), green pod yield per plant (97.91%), ten pod weight (97.87%), plant height (96.98%), days to 50% flowering (96.96%), number of pods per cluster (95.02%), pod width (94.04%), days to first picking (93.01%), pod length (92.21%), number of primary branches per plant (87.20%), number of seeds per pod (75.78%) and plant spread (68.18). The high magnitude of heritability has also been earlier reported for number of seeds per pod and green pod yield by Jogdhande *et al.* (2017) [7], which may be contributed to the preponderance of additive gene action and selection pressure could profitably be applied on these character for improving pod yield. The estimates of genetic advance expressed as percentage of mean (Table 2) were found high for green pod yield per plant followed by number of pods per plant, ten pod weight, plant height, number of primary branches per plant, pod width, pod length and number of pods per cluster. High estimates of genetic advance expressed as percentage of mean in cowpea have also been reported earlier by Nwosu *et al.* (2013) [9] for green pod yield per plant, number of pods per plant and number of pods per cluster.

Table 1: Analysis of variance showing mean squares for 12 characters in 60 genotypes of vegetable cowpea

Source	d. f.	Days to 50% flowering	Days to first green pod picking	No. of primary branches per plant	Plant height (cm)	Pod length (cm)	Pod width (cm)
		1	2	3	4	5	6
Replications	2	2.8222	1.9055	0.0002	32.6695*	0.7257	0.0008
Genotypes	59	64.3216**	56.7919**	0.4376**	280.4968**	8.5790**	0.0163**
Error	118	1.9578	3.9677	0.0560	8.4739	0.6686	0.0009

Table 1: (Contd.)

Source	d. f.	No. of pods per plant	No. of seeds per pod	No. of pods per cluster	Ten pod weight (g)	Plant spread (cm)	Green pod yield per plant (g)
		7	8	9	10	11	12
Replications	2	7.9278*	0.1918	0.0304	14.3128*	5.2237	168.9788*
Genotypes	59	147.5599**	3.4014**	0.2079**	184.5628**	14.9214**	2524.2843**
Error	118	2.1732	0.8238	0.0103	3.9323	4.7474	52.7954

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

Table 2: Mean, Range of variation, coefficient of range, phenotypic (PCV) and genotypic (GCV) coefficients of variation, heritability (broad sense), genetic advance and genetic advance expressed as percentage of mean for 12 characters in 60 genotypes of vegetable cowpea

Character	Mean	Range	Coefficient of range (%)	PCV (%)	GCV (%)	Heritability (broad sense) $h^2_{(bs)}$ (%)	Genetic advance (Gs)	Genetic advance expressed as percentage of mean GAM (%)
Days to 50% flowering	53.96	44.67-65.00	18.53	8.58	8.45	96.96	9.24	17.14
Days to first green pod picking	65.54	57.00-74.00	12.97	6.63	6.40	93.01	8.33	12.72
No. of primary branches per plant	02.41	01.73-03.20	2.98	15.84	14.79	87.20	0.68	28.45
Plant height (cm)	48.61	33.64-73.27	37.06	19.89	19.58	96.98	19.31	39.73
Pod length (cm)	13.07	10.21-16.72	2.41	12.93	12.41	92.21	3.21	24.56
Pod width (cm)	00.55	00.38-00.68	2.83	13.37	12.96	94.04	0.14	25.90
No. of pods per plant	17.62	09.98-33.04	53.60	39.35	39.06	98.53	14.23	79.88

No. of seeds per pod	10.08	08.39-12.58	0.20	10.56	9.19	75.78	1.66	16.48
No. of pods per cluster	02.29	01.59-2.68	25.52	11.48	11.19	95.02	0.51	22.48
Ten pod weight (g)	38.15	21.87-59.50	46.24	20.55	20.33	97.87	15.81	41.45
Plant spread (cm)	26.84	22.75-34.06	19.90	8.31	6.86	68.18	3.13	11.67
Green pod yield per plant (g)	69.11	19.17-142.50	76.28	41.97	41.52	97.91	58.50	84.65

Conclusion

It can be concluded that the highest range of variation, high genotypic coefficient of variation and phenotypic coefficient of variation were observed in green pod yield per plant followed by number of pods per plant and ten pod weight. High heritability along with high genetic advance were observed for green pod yield per plant followed by number of pods per plant, ten pod weight, plant height, number of primary branches per plant, pod width, pod length and number of pods per cluster.

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