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Genetic variability and correlation studies in bush type cowpea (*Vigna unguiculata* L. Walp)

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Abstract
The present experiment on genetic variability and correlation in bush type cowpea was carried out with 20 locally collected genotypes with the objective to improve the yield through selection. The results revealed that wide variability was found for different traits in bush type cowpea. Invariably, higher values were observed for phenotypic coefficient of variation with respect to corresponding genotypic coefficient of variation indicating the impact of environmental factors towards trait expression. High estimates of GCV, heritability (broad sense) and genetic advance as percentage of mean together at a glance were observed for the characters like plant height, number of pods per plant, pod weight and edible pod yield per plant suggesting additive gene action for expression of these characters. Correlation studies among the various traits indicated that there is a strong inherent association between yield per plant with characters like branches per plant, number of pods per plant, pod length, pod girth, number of seeds per pod and 100 seed weight. Further, plant height, number of branches per plant, number of pods per plant, pod length, number of seeds per pod, pod weight, 100 seed weight and pod girth showing significant positive association both at genotypic and phenotypic levels suggested that, these are important correlated characters contributing towards fruit yield of cowpea and simultaneous improvement in these characters will be helpful in bush type cowpea improvement programme.

Keywords: Cowpea, genetic variability, correlation

Introduction
Cowpea (*Vigna unguiculata* L. Walp.) popularly known as black eye pea is an annual, autogamous leguminous crop belonging to Fabaceae family commercially grown throughout India for its green pods and seeds. It has been referred as poor man's meat because of its high protein content (22-25% in mature seeds, 3-4% in green leaves and 4-5% in immature pods which is used as vegetables). It also provides good nutritional security as vegetable containing 0.05 mg thiamine, 0.18 mg riboflavin, 0.6 mg niacin acid, 4 mg vitamin C, 20.1 mg iron, 3-4 g protein, 0.7 g of fats, 1.6 g minerals, 1.2 g fibre, 4.1 g carbohydrates, 89 g of moisture, 38 Kcal energy, 290 mg of Ca and 58 mg of phosphorous per 100 g of edible fruit (T.R Gopal Krishnan, 2007) [6]. It is one of the oldest human food source and has most likely been cultivated since the Neolithic period (Chevalier, 1964) and grows well between 35°N and 30°S of the equator covering Asia, Oceania, the Middle East, Southern Europe, Africa and United states (Fery, 1985) [5]. The improvement of any crop is proportional to the magnitude of its genetic variability present in the germplasm. Genotypic coefficient of variation and phenotypic coefficient of variation suck out the association between yield and yield attributing characters in the crop evaluated. If the association is significant and positive, simultaneous improvement is possible. Further the correlation measure the mutual relation between different characters of a crop which helps to determine the best pair of contributing character towards yield. Keeping this in view, the present investigation was undertaken to assess the genetic variability, association of eleven characters on fruit yield in twenty local germplasms in bush type of cowpea.

Material and Methods
Experimental material consisted of twenty genotypes which were evaluated by adopting Randomized Block Design with three replications during summer of 2021 at Chattabara Research Station, Binjhagiri, Siksha 'O' Anusandhan (Deemed to be University) Bhubaneswar, Odisha, India. The entries were planted in six rows with fourteen plants in each row. The inter and intra row spacing was 45 cm and 15 cm, respectively and all the recommended cultural practices were followed to raise a good crop.

Data on eleven quantitative *viz*, days to 50% flowering, plant height, number of branches per plant, days to edible maturity, number of pods per plant, pod length, pod girth, pod weight,100 seed weight, number of seeds per pod, edible pod yield per plant were recorded. Mean values of five plants from each plot were subjected to analysis to variance. Fruit weight is based on the mean of five fruits from each plot which were used for recording fruit length and fruit girth. Genotypic and phenotypic correlation coefficient was computed by adopting the procedure of Dewey and Lu (1959) [4].

Results and Discussion

Variations were observed among the 20 genotypes of bush type cowpea with respect to fruit yield and yield attributing parameters (Table-1). The data in Table 1 indicated that the phenotypic coefficient of variation (PCV) was higher than genotypic coefficient of variation (GCV) for all the traits studied. The PCV was highest (23.50) for the edible pod yield per plant followed by plant height (21.76) The traits like number of branches per plant (14.87), number of pods per plant (17.53), pod length(17.31), pod girth (14.55), pod weight (16.47), 100 seed weight (11.99) recorded high to moderate value for this parameter. The other characters such as number of seeds per pod (9.77), days to 50% flowering (8.69) and days to edible maturity (6.96) showed lower values for this parameter. More or less similar trend was visualized in the estimate of GCV for all the traits with pod yield per plant having highest value (20.96) followed by plant height (19.56). High to moderate values were obtained for characters like number of branches per plant (12.13), number of pods per plant (15.94), pod length (16.97), pod girth (12.02), pod weight (15.01) and 100 seed weight (10.45) whereas number of seeds per pod (9.77), days to 50% flowering (8.11) and days to edible maturity (6.96) showed lower value. In comparing the PCV and GCV values Table 1, it is observed that in general the former values are greater than the later in respect of all the quantitative characters under study. The PCV being parallel in effect with GCV suggested that phenotype truly represent the genotype. In present investigation, the presence of high to moderate genetic coefficient of variation for edible pod yield per plant, plant height, number of pods per plant, pod length, pod weight, number of branches per plant and pod girth showing high to moderate value depicting the presence of sufficient amount of genetic variability for each character among the germplasm evaluated. So selection based on these characters may be useful in bush type cowpea improvement programme. Heritability estimates (broad sense) presented in Table 1, ranged from 66.59%-96.09%. Highest heritability was observed in pod length (96.09%), days to 50% flowering (87.22%), pod weight (83.00%), number of pods per plant (82.64%) followed by pod girth (68.12%). Whereas high to moderate values were observed in days to edible maturity (73.55%) followed by 100 seed weight (75.96%), edible pod yield per plant (79.55%), number of seeds per pod (79.77%) and plant height (80.85%) in ascending order. Low heritability (66.59%) was observed for number of branches per plant. The information concerning heritability of quantitative character and their genetic and environment variance when considered together might be useful for improving the efficiency of selection (Weber and Moorthy, 1952) [17]. Similar results also reported by Kiran *et al.* (2020), Panchta *et al*. (2020) [10], Purohit *et al*. (2020) [12] and Tambiktar *et al*. (2021) [13] in cowpea with accordance to present findings. A wide variation for genetic advance was recorded (Table1) which varied from 0.50 for pod girth (lowest) to 34.43 for edible pod yield per plant (highest). High genetic advance was also recorded for plant height (26.85). All other remaining characters like days to 50% flowering (5.82), days to edible maturity (4.54), number of pods per plant (2.89), pod length (9.17), pod weight (2.59), 100 seed weight(3.52), number of seeds per pod (2.24) showed low genetic advance (less than 10). However, pod girth (0.50) exhibited lowest genetic advance followed by number of branches (1.08) in magnitude. The expected genetic advance from selection when expressed as percentage of mean is the product of selection differential based on the mean phenotypic values of the selected genotypes included in investigation, heritability of the character under selection and phenotypic standard deviation. The results on correlation studies of eleven important traits of bush type cowpea observed in the present study (Table 2) revealed significant and positive correlation both at genotypic and phenotypic level are observed for edible pod yield per plant with plant height, number of branches per plant, number of pods per plant, pod length, number of seeds per pod, pod weight, 100 seed weight and pod girth. Days to 50% flowering with days to edible maturity and 100 seed weight. Plant height with number of pods per plant and number of seeds per pod. Then number of branches per plant with number of pods per plant, pod weight and 100 seed weight. Number of pods per plant with number of seeds per pod. Pod length with number of seeds per pod, pod weight, pod girth. Number of seeds per pod with pod girth. Pod weight with 100 seed weight, pod girth. These associations suggest that selection for component traits will be simultaneously effective in improving the edible pod yield in bush type cowpea. In agreement to the present findings significant positive correlation was reported by Parmer *et al*. (2003) [11], days to 50% flowering with days to maturity. Narayanankutty *et al*. (2003) [9] edible pod yield per plant with number of pods per plant, pod weight and pod length. Yadav *et al.* (2003) [16] pod yield with plant height, pod length, number of seeds per pod. Anbumallarmathi *et al*. (2005) [2] pod yield per plant with number of pod per plant, pod length, number of seeds per pod and 100 seed weight. Ullah *et al*. (2011) [15] pod yield per plant with pod weight, number of pod per plant, pod length, pod girth. Tudu *et al*. (2015) [14] pod yield with number of branches per plant and number of seeds per pod. Adavbiele *et al*. (2019) [1] pod length with number of seeds per pod. Kalambe *et al*. (2019) [7] yield per plant with plant height, number of branches per plant, number of seeds per pod, pod weight and 100 seed weight. Kumar *et al*. (2020) [8] pod yield per plant with number of pods per plant, number of seeds per pod, number of branches per plant.

Table 1: Genotypic coefficient of variation, phenotypic coefficient of variation, heritability (in broad sense), genetic advance, genetic advance mean for 11 quantitative characters studied in 20 genotype of cowpea

Sl. No.	Characters	PCV (%)	GCV (%)	h2 (%)	GA (at 5% level)	GAM (Genetic advance mean as % of mean)
1	Days to 50% flowering	8.69	8.11	87.22	5.82	15.61
2	Plant height (cm)	21.76	19.56	80.85	26.85	36.24
3	No. of branches per plant	14.87	12.13	66.59	1.08	20.40
4	Days to edible maturity	6.96	5.96	73.55	4.54	10.54
5	No. of pods per plant	17.53	15.94	82.64	2.89	29.85
6	Pod length (cm)	17.31	16.97	96.09	9.17	34.28
7	Pod girth (in cm)	14.55	12.02	68.12	0.50	20.44
8	Pod weight (g)	16.47	15.01	83.00	2.59	28.19
9	100 seed weight (g)	11.99	10.45	75.96	3.52	18.76
10	No. of seeds per pod	9.77	8.72	79.77	2.24	16.05
11	Edible pod yield per plant (g)	23.50	20.96	79.55	34.43	38.57

Table 2: Phenotypic correlation coefficient (rp) and genotypic correlation coefficient between all pairs of 11 quantitative traits/character of cowpea germplasm

Characters		Plant height (cm)	No. of branches per plant	Days to edible maturity	No. of pods per plant	Pod length (cm)	No. of seeds per pod	Pod weight (g)	100 seed weight (g)	Pod girth (cm)	Edible pod yield per plant (g)
Days to 50% flowering	rp	0.084	0.107	0.903**	0.051	0.116	-0.171	0.163	0.294*	-0.182	0.214
	rg	0.110	0.138	0.986**	0.051	0.127	-0.268*	0.149	0.322*	-0.206	0.208
Plant height (cm)	rp		0.156	0.056	0.446**	-0.024	0.274*	0.242	0.105	-0.032	0.507**
	rg		0.222	0.069	0.550**	-0.040	0.306*	0.324*	0.127	-0.076	0.629**
No. of branches per plant	rp			0.089	0.537**	0.208	0.237	0.329*	0.326*	0.054	0.593**
	rg			0.068	0.636**	0.283*	0.357**	0.422**	0.411**	0.128	0.785**
Days to edible maturity	rp				0.004	0.033	-0.245	0.031	0.208	-0.327*	0.101
	rg				0.058	0.054	-0.369**	-0.000	0.314*	-0.346**	0.129
No. of pods per plant	rp					0.001	0.371**	-0.025	0.116	0.097	0.695**
	rg					0.004	0.402**	-0.046	0.020	0.071	0.710**
Pod length (cm)	rp						0.429**	0.406**	0.255*	0.316*	0.295*
	rg						0.491**	0.454**	0.292*	0.383*	0.339**
No. of seeds per pod	rp							0.276*	0.134	0.268*	0.469**
	rg							0.232	0.042	0.324*	0.453**
Pod weight (g)	rp								0.709**	0.325*	0.670**
	rg								0.776**	0.467**	0.675**
100 seed weight (g)	rp									0.170	0.632**
	rg									0.125	0.606**
Pod girth (cm)	rp										0.264*
	rg										0.313*

*and ** indicates significant at 5% and 1% level respectively

Conclusion

From the above discussion on correlation it may be suggested that the plant height, number of branches per plant, number of pods per plant, pod length, pod girth, number of seeds per pod and 100 seed weight are the important correlated characters contributing towards the edible pod yield of bush type cowpea and simultaneous improvement in these characters will be useful in bush type cowpea improvement programme.

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