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Path analysis in cowpea [*Vigna unguiculata* (L.) Walp.]

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Abstract
The experiment was conducted to study on genetic architecture through variability parameters and association analysis for green forage yield and its characters in 78 germplasm lines including 3 checks (MFC-8-14, UPC-5286 and TSFC-12-15); with 3 replication, was carried out during *Rabi* 2015-16 studied for fifteen characters *viz.*, plant height (cm), number of primary branches, days to 50% flowering, pod length (cm) number of locules per pod days to maturity, 100 Seed weight (g), seed yield per plant (g), leaf length (cm), leaf width (cm), leaf stem ratio green forage yield per day (q/ha/day), dry matter yield (q/ha), dry matter yield per day (q/ha/day) and green forage yield (q/ha). All the fifteen characters exhibited existence of variability significantly. This indicated existence of sufficient variability among the genotypes for the mentioned characters and sufficient scope for development of new variety or genotypes. These results are indicates that seed yield can be improved much better way by selection. Selection for these traits is likely to accumulate more additive genes leading to further improvement of performance of genotypes.

Keywords: association analysis, cowpea

Introduction
Cowpea (*Vigna unguiculata* (L.) Walp) 2n=22, a member of the family leguminosae/ fabaceae, is a crop grown throughout the tropics and the substropics. The cowpea is a very old crop, probably native to Central Africa, although it has been grown in South-Eastern Asia for more than 2000 years. Cowpea is one of the most important legume crops. It is now gaining importance in the recent years due to its high food value, good fodder and used as an excellent green manure crop. All the plant parts of cowpea that are used for food are nutritious providing protein, vitamins and minerals. Its grain contains on average 23-25% protein and 50-70% starch. Vir and Singh (2014). Apart from this, cowpea forms excellent forage and it gives a heavy vegetative growth and covers the ground so well that it checks the soil erosion
Grain yield, in cowpea is also a complex character. It depends on the expression of various independent characters. Therefore, selection on the basis of one or more characters may not necessarily lead to the improvement in yield. It is, therefore, essential to know the association of various quantitative as well as qualitative characters in order to initiate an effective selection programme aiming at the improvement of yield. Thus, the present study was carried out to assess the variability with the help of genetic parameters like the coefficient of variability and association analysis.

Materials and Methods
The experimental materials for the present study comprised for RBD 78 germplasm lines including 3 checks (MFC-8-14, UPC-5286 and TSFC-12-15); with 3 replication, was carried out during *Rabi* 2015-16 at Research cum Instructional Farm under on Cowpea, Department of Genetics and Plant breeding, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh. The experimental site is located between 17°14‟N and 24°45‟N latitudes and 79°16‟E and 84°15‟ E longitudes. Raipur is the capital of the Chhattisgarh state and lies at 21°16‟N latitude and 81°36 „E longitude with an altitude of 289.60 meters above mean sea level. The region receives 1200-1400 mm rainfall annually out of which about 8 percent is received during *Rabi* season. The maximum temperature was 43.1 °C and minimum 27.8 °C during the crop growth period. All recommended production and protection practices were followed to raise a good crop. The measure of direct and indirect effects were carried out according to the method developed by Wright (1921) [5]. Data of each character was subjected to analysis to calculate

means, minimum and maximum values, variances and standard errors (SE) through MS Excel Software.

Results and Discussion

Analysis of variance

Analysis of variance was carried out for fifteen characters. The characters under study *viz.*, plant height (cm), number of primary branches, days to 50% flowering, pod length (cm), number of locules per pod, day of maturity, 100-seed weight (g), seed yield/ plant (g), leaf length (cm), leaf width (cm), leaf stem ratio, green forage yield per day (q/ha/day), dry matter yield(q/ha), dry matter yield per day (q/ha/day), and green forage yield (q/ha) exhibited existence of variability significant at 1% significant level, is presented in Table-1. This indicated existence of sufficient variability among the genotypes for the mentioned characters and sufficient scope for development of genotypes.

Table 1: Analysis of variance for Green forage yield and its attributing traits in Cowpea.

		Mean sum of squares														
Source of variation	**Degree of freedom**	**PH**	**NPB**	**DFF**	**PL**	**NL**	**DM**	**SW**	**SYP**	**LL**	**LW**	**LSR**	**GFYD**	**DMY**	**DMYD**	**GFY**
Replication	2	20.26	2.95	65.47	10.17	19.29	105.88	12.09	0.42	0.54	0.59	0.02	0.03	0.03	0.02	0.03
Treatment	77	5471.44**	12.03**	438.41**	80.43**	15.36**	725.17**	48.30**	28.26**	8.11**	5.60**	0.14**	0.001**	0.234**	0.02**	.07**
Error	154	5.99	0.28	2.59	2.64	2.30	6.15	0.03	0.11	0.14	0.16	0.02	0.11	0.01	0.01	0.11

** Significant at 1% probability level, *Significant at 5% probability level

1) PH = Plant height (cm),
2) NPB = Number of primary branches,
3) DFF = Days to 50% flowering,
4) PL = Pod length (cm),
5) NL = Number of locules per pod
6) DM = Days to maturity,
7) SW=100 Seed weight (g),
8) SYP = Seed yield per plant (g),
9) LL = Leaf length (cm),
10) LW = Leaf width (cm),
11) LSR = Leaf stem ratio
12) GFYD=Green forage yield per day (q/ha/day)
13) DMY = Dry matter yield (q/ha)
14) DMYD = Dry matter yield per day (q/ha/day)
15) GFY = Green forage yield (q/ha)

Genotypic path coefficient analysis with seed yield per plant as dependent character

In path analysis when seed yield per plant was considered as dependent trait has been presented in Table-2. Maximum positive direct effect was obtained for dry matter yield per day (6.4613) followed by green forage yield per day (1.8625), pod length (0.7185) and leaf width (0.2728), whereas negative direct effect were obtained *via,* dry matter yield per day (-6.4965) followed by green forage yield (-2.0378), leaf length (-0.2870) and days to maturity (-0.0005).

Forage yield exhibited positive indirect effect on dry matter yield per day (4.7213) followed pod length (0.2342) and positive significant correlation with seed yield per plant (0.2520). Green forage yield per day showed positive indirect effect on dry matter yield per day (4.7075) followed by pod length (0.2393) and Number of primary branches (0.0591) and positive significant correlation with seed yield per plant (0.2590). Dry matter yield exhibited positive indirect effect on green forage yield per day (1.3535) and pod length (0.1247) and positive correlation with seed yield per plant (0.1200). Dry matter yield per day exhibited positive indirect effect on green forage per day (1.3570) followed by pod length (0.1298) and Number of primary branches (0.0629) and positive correlation with seed yield per plant (0.1210). Seed yield per plant was considered as dependent trait, maximum positive direct effect was obtained for dry matter yield per day followed by green forage yield per day, pod length and leaf width, whereas negative direct effect were obtained *via*, dry matter yield per day followed by green forage yield, leaf length and days to maturity Animasaun *et al.* (2015) [1] and Meena *et al.* (2014) [2] and Pratishtha *et al*. (2017) [3].

Table 2: Path coefficient analysis matrix of direct and indirect effects when Seed yield per plant is taken as dependent character

Character	PH	NPB	DFF	PL	NL	DM	SW	LL	LW	LSR	GFY	GFYD	DMY	DMYD	Correlation with SYP
PH	0.1497	-0.0069	-0.0006	0.1692	0.0082	0.0000	0.0262	-0.0024	-0.0214	-0.0403	-0.4689	0.4410	-1.1431	1.1679	0.278**
NPB	-0.0069	0.1488	0.0013	0.1074	0.0049	-0.0001	-0.0424	0.0354	0.0148	0.0642	-0.8177	0.7395	-2.8287	2.7312	0.152*
DFF	-0.0077	0.0167	0.0118	-0.0386	0.0010	-0.0005	-0.0522	-0.0229	0.0538	0.0347	-0.2546	0.2225	-0.4254	0.4108	-0.0510
PL	0.0352	0.0223	-0.0006	0.7185	0.0296	0.0000	0.0154	0.0444	-0.0041	0.0125	-0.6643	0.6204	-1.1271	1.1671	0.869**
NL	0.0278	0.0165	0.0003	0.4814	0.0441	0.0000	-0.0159	0.0011	0.0393	0.0043	-0.7781	0.7250	-1.0643	1.0936	0.575**
DM	-0.0067	0.0251	0.0110	-0.0181	0.0025	-0.0005	-0.0575	-0.0349	0.0686	0.0346	-0.4418	0.3930	-0.6211	0.6337	-0.0120
SW	0.0169	-0.0272	-0.0027	0.0477	-0.0030	0.0001	0.2319	-0.0494	-0.0017	-0.0158	-0.3740	0.3501	-1.0082	0.9900	0.155*
LL	0.0013	-0.0184	0.0010	-0.1110	-0.0002	-0.0001	0.0399	-0.2870	0.2146	0.0001	-0.0003	-0.0034	-0.5428	0.5606	-0.146*
LW	-0.0117	0.0081	0.0023	-0.0108	0.0064	-0.0001	-0.0014	-0.2257	0.2728	0.0156	-0.0315	0.0185	-0.2558	0.1978	-0.0160
LSR	-0.0370	0.0586	0.0025	0.0550	0.0012	-0.0001	-0.0226	-0.0002	0.0261	0.1629	-0.6166	0.5502	-1.6587	1.6318	0.153*
GFY	0.0344	0.0597	0.0015	0.2342	0.0168	-0.0001	0.0426	-0.0001	0.0042	0.0493	-2.0378	1.8621	-4.7364	4.7213	0.252*
GFYD	0.0354	0.0591	0.0014	0.2393	0.0172	-0.0001	0.0436	0.0005	0.0027	0.0481	-2.0374	1.8625	-4.7210	4.7075	0.259**
DMY	0.0263	0.0648	0.0008	0.1247	0.0072	-0.0001	0.0360	-0.0240	0.0107	0.0416	-1.4857	1.3535	-6.4965	6.4612	0.1200
DMYD	0.0271	0.0629	0.0008	0.1298	0.0075	-0.0001	0.0355	-0.0249	0.0084	0.0411	-1.4891	1.3570	-6.4964	6.4613	0.1210

Residual effect = 0.22098

Diagonal values showed direct effect on seed yield per plant (g)

1) PH = Plant height (cm),
2) NPB = Number of primary branches,
3) DFF = Days to 50% flowering,
4) PL = Pod length (cm),
5) NL = Number of locules per pod
6) DM = Days to maturity,
7) SW=100 Seed weight (g),
8) SYP = Seed yield per plant (g),
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10) LW = Leaf width (cm),
11) LSR = Leaf stem ratio
12) GFYD = Green forage yield per day (q/ha/day)
13) DMY = Dry matter yield (q/ha)
14) DMYD = Dry matter yield per day (q/ha/day)
15) GFY = Green forage yield (q/ha)

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