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Early generation selection for green pod yield and its components in vegetable cowpea [*Vigna unguiculata* (L.) Walp.]

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ABSTRACT : Correlation and path co-efficient analysis were carried out in parents, F₁ and F₂ generations of 6 × 4 parental line x tester cross in cowpea. Experiment comprising of 60 diverse vegetable cowpea genotypes was carried out at Horticultural research cum instructional farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur during *Kharif* of 2008. The result of correlation study in all three generations showed that green pod yield per plant had significant and positive correlation with number of pods per plant, pod length and pod weight. In base population, F₁ and F₂ the path analysis revealed that number of pods per cluster, days to final picking, pod weight and fruiting duration expressed a highest positive direct effect on green pod yield per plant, respectively. The correlation and path analysis studies revealed that 100 seed weight, pod weight, pod length and number of pods per plant were major components of green pod yield in early generations of vegetable cowpea. Hence, the direct selection in form of selection indices based on these component characters would be effective in development of high yielding genotypes of vegetable cowpea.

KEY WORDS : Cowpea, Correlation, Path analysis

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Cowpea [*Vigna unguiculata* (L.) Walp.] is one of the most important crop in India, used for vegetable, pulse and fodder. It is a self pollinated crop and the procedures in use for the varietal development have followed the traditional breeding methods such as individual plant selection in naturally occurring or hybridization induced genetic variability followed by pedigree method (Allard, 1960). An important assumption underlying early generation selection generally adopted for self-pollinated crops is that selection for the character in early generation F₁, F₂ and F₃ would be effective as when practiced in the later generations. The early generation testing to identify superior genotype and eliminate large amount of materials with increasing breeding efficiency of the programme (Allard, 1960).

Hence, important traits could be identified for selection in early generations. Hence, the genetic potentialities of green pod yield contributing characters and their interrelationship should be properly assessed for improvement in this crop (Jana *et al.*, 1983). Therefore, an attempt has been made to assess the factors determining green pod yield in early generation of cowpea through correlation co-efficient and path co-efficient analysis. Keeping these views present investigation was carried out to study correlation and path analysis for various characters.

RESEARCH METHODS

A base population of sixty genotypes collected from various parts of Chhattisgarh was grown in *Kharif* 2007

and from them diverse ten parents (six lines and four testers) were selected through genetic divergence analysis. All populations *viz.*, base population including parents, twenty four F_1 progenies of selected parents in line x tester (6 x 4) matting fashion and their F_2 progenies were grown during *Kharif* season of 2008 at Department of Horticulture, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.). The experiment was laid out in Randomized Block Design with three replications. Each genotype consisted of three rows of 3.15 m long and 7 plants in each row. The spacing given was 60 cm between rows and 45 cm within a row. Observations were recorded on five randomly selected competitive plants from each genotype except 100 grain weight. Statistical analysis was done as methods suggested by Panse and Sukhatme (1978) and Singh and Chaudhary (1985).

RESEARCH FINDINGS AND DISCUSSION

The correlation co-efficient analysis for green pod yield and its contributing characters for base population, F_1 and F_2 are presented in Table 1, 2 and 3, respectively. Green pod yield per plant expressed a highly significant positive correlation with 100 seed weight at phenotypic, genotypic and environmental levels and it also showed significant correlation with number of pods per plant at phenotypic, genotypic and environmental levels. Green pod yield per plant also showed significant positive correlation with pod length and pod weight at phenotypic and genotypic levels. It had also significant positive correlation with fruiting duration at genotypic level and plant height, number of branches per plant and number of nodes per plant at environmental level. It also showed significant negative correlation with days to 50 per cent flowering, days to first picking and per cent protein content in green pods at phenotypic and genotypic levels. The other significant positive correlation was recorded in days to first flowering with days to 50 per cent flowering and days to first picking and days to 50 per cent flowering with days to first picking at phenotypic, genotypic and environmental levels. Similar results have been reported by earlier workers Jana *et al.* (1983); Selvaum and Das (1994); Resmi (1998) and Kutty *et al.* (2003).

The correlation co-efficient analysis for green pod yield and its contributing characters for F_1 is given in Table 2. Green pod yield per plant expressed a highly significant positive correlation with 100 seed weight and

number of pods per plant at phenotypic, genotypic and environmental levels and it also showed significant correlation with pod weight, pod length and fruiting duration at phenotypic and genotypic levels. Whereas, significant negative correlation with per cent protein content in green pods at phenotypic and genotypic levels. In F_1 the other significant and positive correlation was observed between plant height with days to last picking, days to first flower with days to 50 per cent flowering and both with days to first picking, days to last picking, number of flowers per cluster with number of pods per cluster and days to first picking with days to last picking at all the three levels. Pod weight with fruiting duration and 100 seed weight, pod length with pod weight, fruiting duration and 100 seed weight, number of pods per cluster with days to first picking, number of pods per plant and per cent protein content in green pods, number of flowers per cluster with number of pods per cluster, days to first flower with number of pods per cluster and per cent protein content in green pods, plant height with days to first flower and first picking at phenotypic and genotypic levels. The above findings are in agreement with Chattopadhyay *et al.* (1997); Singh *et al.* (1998); Vidya and Oommen (2002); Venkatesan *et al.* (2003); Yadav *et al.* (2003) and Lovely and Radhadevi (2006).

In F_2 generation the green pod yield per plant expressed a highly significant positive correlation with pod length, number of pods per plant and number of pickings at phenotypic, genotypic and environmental levels. It also showed highly significant correlation with pod weight and 100 seed weight at phenotypic and genotypic levels. Green pod yield per plant also showed significant positive correlation with number of seeds per pod and fruiting duration at phenotypic and genotypic level. It had also significant positive correlation with plant height at genotypic level only. It also showed significant negative correlation with number of branches per plant, days to first flowering, days to 50 per cent flowering, days to first picking and per cent protein content in green pods. The other significant and positive correlation between traits were recorded for pod length with pod weight, number of pods per plant, number of pickings and green pod yield per plant, plant height with days to final picking and fruiting duration, days to first flower was observed with days to 50 per cent flowering and days to first picking at phenotypic, genotypic and environmental levels, pod length with number of seeds per pod fruiting duration and 100 seed weight, pod weight

Table 1 : Correlation analysis (phenotypic, genotypic and environmental) among green pod yield and its components in base population of vegetable cowpea

Characters		2	3	4	5	6	7	8	09	10	11	12	13	14	15	16
Plant height (cm)	P	-0.021	0.388*	0.304	0.199	0.072	0.385*	0.437*	-0.018	0.001	0.050	0.151	-0.062	0.122	0.019	0.060
	G	-0.083	0.405*	0.318	0.227	0.098	0.404*	0.403*	-0.004	0.005	-0.044	0.215	-0.076	0.114	-0.069	-0.015
	E	0.381*	0.205	0.208	0.001	-0.119	0.187	0.643**	-0.184	-0.099	0.707**	0.063	-0.009	0.176	0.563*	0.678**
Number of branches/ plant	P	1.000	0.012	0.003	0.157	0.011	-0.001	0.029	-0.255	-0.090	0.134	-0.016	-0.026	0.004	0.018	0.047
	G	1.000	0.005	0.000	0.197	0.038	-0.012	-0.065	-0.285	-0.088	0.077	-0.075	-0.026	0.004	-0.079	-0.019
	E	1.000	0.114	0.081	-0.074	-0.154	0.120	0.428*	0.001	-0.175	0.467*	0.105	-0.025	0.004	0.517*	0.506*
Days to first flower	P		1.000	0.971**	0.268	0.447*	0.983**	0.580*	-0.450*	-0.484*	0.130	-0.096	-0.563*	0.573*	-0.465*	-0.389*
	G		1.000	0.976**	0.291	0.480*	0.985**	0.651**	-0.467*	-0.497*	0.122	-0.131	-0.632**	0.614**	-0.529*	-0.428*
	E		1.000	0.871**	0.024	0.062	0.917**	0.209	-0.054	-0.012	0.277	-0.073	-0.344	0.160	0.138	0.175
Days to 50% flowering	P			1.000	0.289	0.488*	0.960**	0.595*	-0.459*	-0.477*	0.114	-0.117	-0.508*	0.577*	-0.475*	-0.399*
	G			1.000	0.311	0.517*	0.968**	0.672**	-0.472*	-0.483*	0.113	-0.169	-0.585*	0.619**	-0.530*	-0.427*
	E			1.000	0.041	0.169	0.793**	0.191	-0.057	-0.050	0.259	-0.053	-0.213	0.083	0.141	0.139
Number of flowers/cluster	P				1.000	0.552*	0.261	0.146	-0.415*	-0.273	0.220	-0.116	-0.161	0.432*	-0.229	-0.121
	G				1.000	0.619**	0.281	0.177	-0.452*	-0.303	0.259	-0.187	-0.192	0.498*	-0.256	-0.124
	E				1.000	0.106	0.077	0.011	-0.077	0.111	-0.028	0.001	-0.042	0.015	-0.077	-0.097
Number of pods/cluster	P					1.000	0.433*	0.204	-0.482*	-0.414*	0.412*	-0.276	-0.284	0.497*	-0.238	-0.131
	G					1.000	0.464*	0.276	-0.533*	-0.444*	0.491*	-0.361*	-0.341	0.589*	-0.262	-0.132
	E					1.000	0.098	-0.137	0.055	-0.028	-0.116	-0.190	-0.057	-0.122	-0.097	-0.122
Days to first picking	P						1.000	0.612**	-0.435*	-0.472*	0.117	-0.079	-0.543*	0.528*	-0.470*	-0.394*
	G						1.000	0.692**	-0.455*	-0.487*	0.110	-0.106	-0.611**	0.564*	-0.535*	-0.434*
	E						1.000	0.171	-0.021	0.006	0.232	-0.064	-0.304	0.179	0.105	0.148
Days to final picking	P							1.000	-0.155	-0.095	-0.035	-0.016	0.196	0.315	-0.136	-0.080
	G							1.000	-0.171	-0.100	-0.204	-0.022	0.235	0.354	-0.331	-0.230
	E							1.000	-0.084	-0.123	0.740**	-0.008	0.078	0.149	0.652**	0.720
Pod length (cm)	P								1.000	0.808**	-0.376*	0.243	0.349*	-0.526*	0.583*	0.563**
	G								1.000	0.839**	-0.404*	0.319	0.425*	-0.588*	0.654**	0.615**
	E								1.000	-0.026	-0.121	0.205	-0.048	0.080	0.021	-0.056
Pod weight (g)	P									1.000	-0.386*	0.199	0.465*	-0.503*	0.632**	0.619**
	G									1.000	-0.410*	0.301	0.543*	-0.551*	0.710**	0.671**
	E									1.000	-0.182	-0.015	0.090	0.077	-0.133	-0.223
Number of pods /plant	P										1.000	0.009	-0.259	0.182	0.222	0.323
	G										1.000	-0.005	-0.327	0.190	0.138	0.348*
	E										1.000	0.047	0.002	0.128	0.692**	0.878**
Number of seeds/pods	P											1.000	0.090	-0.170	0.188	0.176
	G											1.000	0.113	-0.252	0.271	0.253
	E											1.000	0.064	-0.046	0.071	0.062
Fruiting duration (days)	P												1.000	-0.311	0.332	0.304
	G												1.000	-0.359	0.422*	0.381*
	E												1.000	-0.137	0.015	-0.025
Protein % (green pod)	P													1.000	-0.473*	-0.393*
	G													1.000	-0.573*	-0.460*
	E													1.000	0.086	0.102
100 seed weight (g)	P														1.000	0.870**
	G														1.000	0.888**
	E														1.000	0.786**
Green pod yield/ plant (g)	P															1.000
	G															1.000
	E															1.000

* and ** indicate significance of value at P=0.01 and P=0.05, respectively

Table 2 : Correlation analysis (phenotypic, genotypic and environmental) among green pod yield and its components in F₁ of vegetable cowpea

Characters		2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Plant height	P	0.010	0.361*	0.304	0.234	0.129	0.363*	0.439*	0.035	0.053	0.095	0.187	0.014	0.101	0.096	0.136
	G	-0.067	0.378*	0.318	0.241	0.123	0.380*	0.444*	0.043	0.059	0.016	0.235	-0.014	0.097	0.022	0.076
	E	0.458*	0.182	0.137	0.190	0.167	0.177	0.499*	-0.067	-0.050	0.690**	0.107	0.122	0.131	0.583*	0.671**
Number of branches/ plant	P	1.000	-0.061	-0.071	0.173	0.078	0.066	0.042	-0.056	0.076	0.187	0.044	0.069	-0.073	0.218	0.266
	G	1.000	-0.082	-0.083	0.153	0.037	-0.088	-0.074	-0.070	0.097	0.122	-0.017	0.033	-0.090	0.137	0.213
	E	1.000	0.114	0.043	0.269	0.271	0.114	0.387*	0.051	-0.146	0.530*	0.186	0.171	0.010	0.594*	0.618**
Days to 1 st flower	P		1.000	0.978**	0.276	0.443*	0.979**	0.584*	-0.446*	-0.495*	0.133	-0.088	-0.463*	0.597*	-0.474*	-0.383*
	G		1.000	0.986**	0.302	0.483*	0.979**	0.672**	-0.464*	-0.512*	0.128	-0.105	-0.578*	0.643**	-0.541*	-0.421*
	E		1.000	0.763**	0.054	0.107	0.987**	0.345*	-0.077	-0.015	0.213	-0.092	-0.109	0.138	0.118	0.140
Days to 50 % Flowering	P			1.000	0.287	0.458*	0.962**	0.580*	-0.464*	-0.504*	0.129	-0.097	-0.444*	0.582*	-0.497*	-0.401*
	G			1.000	0.314	0.494*	0.972**	0.673**	-0.482*	-0.517*	0.129	-0.127	-0.566*	0.625**	-0.555*	-0.431*
	E			1.000	0.015	0.155	0.753**	0.342*	0.015	-0.001	0.169	-0.046	0.006	0.102	0.085	0.075
Number of flowers/cluster	P				1.000	0.568*	0.271	0.195	-0.364*	-0.259	0.255	-0.044	-0.093	0.414*	-0.160	-0.058
	G				1.000	0.606**	0.296	0.209	-0.410*	-0.282	0.256	-0.108	-0.168	0.478*	-0.236	-0.098
	E				1.000	0.358*	0.058	0.161	0.049	-0.035	0.254	0.114	0.130	0.018	0.259	0.237
Number of pods/cluster	P					1.000	0.425*	0.285	-0.427*	-0.368*	0.446*	-0.175	-0.146	0.468*	-0.134	-0.008
	G					1.000	0.464*	0.306	-0.490*	-0.398*	0.476*	-0.250	-0.284	0.551*	-0.212	-0.047
	E					1.000	0.106	0.238	0.129	-0.103	0.265	-0.020	0.260	-0.034	0.281	0.273
Days to 1 st picking	P						1.000	0.615**	-0.436*	-0.487*	0.125	-0.077	-0.451*	0.550*	-0.486*	-0.389*
	G						1.000	0.711**	-0.455*	-0.505*	0.119	-0.090	-0.563*	0.592*	-0.555*	-0.429*
	E						1.000	0.339*	-0.064	-0.011	0.205	-0.083	-0.111	0.144	0.101	0.129
Days to last picking	P							1.000	-0.113	-0.088	0.108	-0.042	0.300	0.322	-0.041	0.045
	G							1.000	-0.138	-0.101	-0.017	-0.094	0.181	0.384*	-0.210	-0.066
	E							1.000	-0.014	-0.072	0.602**	0.041	0.531*	0.129	0.522*	0.557*
Pod length	P								1.000	0.797**	-0.332	0.275	0.364*	-0.507*	0.575*	0.550*
	G								1.000	0.830**	-0.369*	0.347*	0.466*	-0.566*	0.632**	0.590*
	E								1.000	-0.081	0.038	0.170	0.022	0.100	0.125	0.049
Pod weight	P									1.000	-0.349*	0.233	0.459*	-0.489*	0.611**	0.613**
	G									1.000	-0.368*	0.310	0.581*	-0.535*	0.682**	0.660**
	E									1.000	-0.163	0.073	0.030	0.083	-0.099	-0.177
Number of pods /plant	P										1.000	0.074	-0.089	0.181	0.260	0.365*
	G										1.000	0.060	-0.186	0.188	0.189	0.343*
	E										1.000	0.134	0.226	0.134	0.686**	0.872**
Number of seeds/pods	P											1.000	0.049	-0.161	0.223	0.222
	G											1.000	0.013	-0.223	0.272	0.272
	E											1.000	0.102	-0.031	0.144	0.147
Fruiting duration	P												1.000	-0.277	0.437*	0.425*
	G												1.000	-0.364*	0.526*	0.517*
	E												1.000	-0.029	0.221	0.182
Protein % (green pod)	P													1.000	-0.446*	-0.364*
	G													1.000	-0.536*	-0.423*
	E													1.000	0.086	0.100
100 seed weight	P														1.000	0.864**
	G														1.000	0.880**
	E														1.000	0.783**
Green pod yield/ plant (g)	P															1.000
	G															1.000
	E															1.000

* and ** indicate significance of values at P=0.01 and P=0.05, respectively

Table 3 : Correlation analysis (phenotypic, genotypic and environmental) among green pod yield and its components in F₂ population of vegetable cowpea

Characters		2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Plant height (cm)	P	-0.538**	0.026	0.010	-0.138	0.152	0.040	0.692**	0.202	0.401*	-0.078	0.125	0.610**	-0.066	0.071	0.324
	G	-0.618**	0.022	0.002	-0.160	0.165	0.044	0.801**	0.232	0.437*	-0.084	0.307	0.712**	-0.114	0.083	0.358*
	E	-0.068	0.044	0.060	0.080	0.060	0.022	-0.186	-0.050	0.059	-0.066	-0.344*	-0.175	0.187	-0.046	0.009
Number of branches/ plant	P	1.000	0.212	0.219	-0.158	0.178	0.212	-0.495*	-0.433*	-0.469*	0.081	-0.309	-0.533**	0.566**	-0.387*	-0.367*
	G	1.000	0.307	0.281	-0.183	0.229	0.318	-0.556**	-0.477*	-0.514*	0.110	-0.486*	-0.623**	0.662**	-0.434*	-0.403*
	E	1.000	-0.323	-0.175	0.123	-0.278	-0.311	0.050	-0.029	0.056	-0.006	0.143	0.249	0.015	0.100	0.026
Days to first flower	P	1.000	0.915**	-0.082	0.463*	0.980**	-0.071	-0.638**	-0.524**	-0.160	-0.432*	-0.454*	0.665**	-0.697**	-0.447*	
	G	1.000	0.936**	-0.113	0.519**	0.987**	-0.101	-0.714**	-0.565**	-0.204	-0.675**	-0.456*	0.803**	-0.794**	-0.488*	
	E	1.000	0.800**	0.228	0.075	0.955**	0.170	-0.077	-0.243	-0.039	0.125	-0.487*	-0.028	0.111	-0.130	
Days to 50% flowering	P	1.000	0.915**	-0.082	0.463*	0.980**	-0.071	-0.638**	-0.524**	-0.160	-0.432*	-0.454*	0.665**	-0.697**	-0.447*	
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Days to first picking	P	1.000	0.915**	-0.082	0.463*	0.980**	-0.071	-0.638**	-0.524**	-0.160	-0.432*	-0.454*	0.665**	-0.697**	-0.447*	
	G	1.000	0.936**	-0.113	0.519**	0.987**	-0.101	-0.714**	-0.565**	-0.204	-0.675**	-0.456*	0.803**	-0.794**	-0.488*	
	E	1.000	0.800**	0.228	0.075	0.955**	0.170	-0.077	-0.243	-0.039	0.125	-0.487*	-0.028	0.111	-0.130	
Days to final picking	P	1.000	0.915**	-0.082	0.463*	0.980**	-0.071	-0.638**	-0.524**	-0.160	-0.432*	-0.454*	0.665**	-0.697**	-0.447*	
	G	1.000	0.936**	-0.113	0.519**	0.987**	-0.101	-0.714**	-0.565**	-0.204	-0.675**	-0.456*	0.803**	-0.794**	-0.488*	
	E	1.000	0.800**	0.228	0.075	0.955**	0.170	-0.077	-0.243	-0.039	0.125	-0.487*	-0.028	0.111	-0.130	
Pod length (cm)	P	1.000	0.915**	-0.082	0.463*	0.980**	-0.071	-0.638**	-0.524**	-0.160	-0.432*	-0.454*	0.665**	-0.697**	-0.447*	
	G	1.000	0.936**	-0.113	0.519**	0.987**	-0.101	-0.714**	-0.565**	-0.204	-0.675**	-0.456*	0.803**	-0.794**	-0.488*	
	E	1.000	0.800**	0.228	0.075	0.955**	0.170	-0.077	-0.243	-0.039	0.125	-0.487*	-0.028	0.111	-0.130	
Pod weight (g)	P	1.000	0.915**	-0.082	0.463*	0.980**	-0.071	-0.638**	-0.524**	-0.160	-0.432*	-0.454*	0.665**	-0.697**	-0.447*	
	G	1.000	0.936**	-0.113	0.519**	0.987**	-0.101	-0.714**	-0.565**	-0.204	-0.675**	-0.456*	0.803**	-0.794**	-0.488*	
	E	1.000	0.800**	0.228	0.075	0.955**	0.170	-0.077	-0.243	-0.039	0.125	-0.487*	-0.028	0.111	-0.130	
Number of pods /plant	P	1.000	0.915**	-0.082	0.463*	0.980**	-0.071	-0.638**	-0.524**	-0.160	-0.432*	-0.454*	0.665**	-0.697**	-0.447*	
	G	1.000	0.936**	-0.113	0.519**	0.987**	-0.101	-0.714**	-0.565**	-0.204	-0.675**	-0.456*	0.803**	-0.794**	-0.488*	
	E	1.000	0.800**	0.228	0.075	0.955**	0.170	-0.077	-0.243	-0.039	0.125	-0.487*	-0.028	0.111	-0.130	
Number of seeds/pods	P	1.000	0.915**	-0.082	0.463*	0.980**	-0.071	-0.638**	-0.524**	-0.160	-0.432*	-0.454*	0.665**	-0.697**	-0.447*	
	G	1.000	0.936**	-0.113	0.519**	0.987**	-0.101	-0.714**	-0.565**	-0.204	-0.675**	-0.456*	0.803**	-0.794**	-0.488*	
	E	1.000	0.800**	0.228	0.075	0.955**	0.170	-0.077	-0.243	-0.039	0.125	-0.487*	-0.028	0.111	-0.130	
Fruiting duration (days)	P	1.000	0.915**	-0.082	0.463*	0.980**	-0.071	-0.638**	-0.524**	-0.160	-0.432*	-0.454*	0.665**	-0.697**	-0.447*	
	G	1.000	0.936**	-0.113	0.519**	0.987**	-0.101	-0.714**	-0.565**	-0.204	-0.675**	-0.456*	0.803**	-0.794**	-0.488*	
	E	1.000	0.800**	0.228	0.075	0.955**	0.170	-0.077	-0.243	-0.039	0.125	-0.487*	-0.028	0.111	-0.130	
Protein % (green pod)	P	1.000	0.915**	-0.082	0.463*	0.980**	-0.071	-0.638**	-0.524**	-0.160	-0.432*	-0.454*	0.665**	-0.697**	-0.447*	
	G	1.000	0.936**	-0.113	0.519**	0.987**	-0.101	-0.714**	-0.565**	-0.204	-0.675**	-0.456*	0.803**	-0.794**	-0.488*	
	E	1.000	0.800**	0.228	0.075	0.955**	0.170	-0.077	-0.243	-0.039	0.125	-0.487*	-0.028	0.111	-0.130	
100 seed weight (g)	P	1.000	0.915**	-0.082	0.463*	0.980**	-0.071	-0.638**	-0.524**	-0.160	-0.432*	-0.454*	0.665**	-0.697**	-0.447*	
	G	1.000	0.936**	-0.113	0.519**	0.987**	-0.101	-0.714**	-0.565**	-0.204	-0.675**	-0.456*	0.803**	-0.794**	-0.488*	
	E	1.000	0.800**	0.228	0.075	0.955**	0.170	-0.077	-0.243	-0.039	0.125	-0.487*	-0.028	0.111	-0.130	
Green pod yield/ plant (g)	P	1.000	0.915**	-0.082	0.463*	0.980**	-0.071	-0.638**	-0.524**	-0.160	-0.432*	-0.454*	0.665**	-0.697**	-0.447*	
	G	1.000	0.936**	-0.113	0.519**	0.987**	-0.101	-0.714**	-0.565**	-0.204	-0.675**	-0.456*	0.803**	-0.794**	-0.488*	
	E	1.000	0.800**	0.228	0.075	0.955**	0.170	-0.077	-0.243	-0.039	0.125	-0.487*	-0.028	0.111	-0.130	

* and ** indicate significance of values at P=0.01 and P=0.05, respectively

Table 4 : Genotypic and phenotypic path co-efficient analysis for green pod yield and its components in base population of vegetable cowpea

Characters	G/P	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Plant height (cm)	G	-0.057	-0.004	-0.093	-0.198	-0.095	0.153	0.340	-0.032	-0.008	0.004	0.031	0.038	-0.017	0.009	-0.086
	P	-0.019	-0.006	0.072	-0.053	0.074	-0.004	-0.011	0.013	-0.002	-0.012	0.006	0.003	-0.003	-0.004	0.006
Number of branches/ plant	G	0.015	0.045	-0.001	0.012	-0.048	0.097	-0.010	0.025	-0.007	-0.044	-0.054	-0.013	-0.002	-0.004	-0.030
	P	0.003	0.013	0.002	0.002	0.058	-0.001	0.001	0.001	-0.023	-0.039	0.016	0.003	-0.001	0.006	0.006
Days to first flower	G	-0.023	-0.065	-0.181	-0.727	-0.152	0.854	0.830	-0.082	-0.012	-0.459	-0.119	-0.083	-0.056	0.047	-0.200
	P	-0.008	-0.023	0.186	-0.164	0.099	-0.032	-0.027	0.017	-0.040	-0.209	0.015	-0.002	-0.027	-0.020	-0.154
Days to 50% flowering	G	-0.088	-0.034	-0.197	-0.622	-0.107	0.820	0.716	-0.054	-0.028	-0.349	-0.079	-0.030	-0.072	0.047	-0.350
	P	-0.006	-0.022	0.181	-0.138	0.107	-0.027	-0.026	0.018	-0.041	-0.205	-0.013	-0.002	-0.025	-0.029	-0.171
Number of flowers/cluster	G	-0.013	0.009	-0.053	-0.194	-0.344	0.901	0.237	-0.014	-0.024	-0.319	-0.191	-0.033	-0.027	0.038	-0.097
	P	-0.004	0.002	0.050	-0.140	0.370	-0.031	-0.012	0.004	-0.037	-0.218	0.025	-0.022	-0.018	-0.015	-0.073
Number of pods/cluster	G	-0.026	0.002	-0.087	-0.392	-0.263	1.278	0.391	-0.022	-0.034	-0.391	-0.412	-0.083	-0.039	0.045	-0.099
	P	-0.011	0.001	0.083	-0.067	0.210	-0.056	-0.012	0.006	-0.043	-0.178	0.048	-0.005	-0.014	-0.017	-0.076
Days to first picking	G	-0.023	-0.001	-0.279	-0.702	-0.097	0.725	0.843	-0.096	-0.072	-0.381	-0.097	-0.019	-0.054	0.043	-0.224
	P	-0.015	-0.001	0.183	-0.152	0.097	-0.024	-0.027	0.018	-0.039	-0.233	0.014	-0.002	-0.026	-0.018	-0.169
Days to final picking	G	-0.023	-0.016	-0.138	-0.488	-0.061	0.391	0.483	-0.081	-0.004	-0.092	0.122	-0.004	0.011	0.022	-0.145
	P	-0.008	-0.001	0.108	-0.092	0.054	-0.011	-0.027	0.030	-0.014	-0.051	-0.004	-0.001	0.009	-0.011	-0.061
Pod length (cm)	G	0.020	-0.013	0.085	0.293	0.186	-0.908	-0.323	0.014	0.026	0.626	0.282	0.067	0.038	-0.045	0.267
	P	0.001	-0.003	-0.094	0.073	-0.144	0.027	0.012	-0.005	0.089	0.388	-0.034	0.015	0.017	0.025	0.196
Pod weight (g)	G	0.010	-0.004	0.090	0.300	0.104	-0.790	-0.410	0.008	0.021	0.722	0.296	0.053	0.048	-0.042	0.268
	P	0.004	-0.001	-0.090	0.066	-0.101	0.023	0.013	-0.003	0.072	0.431	-0.045	0.004	0.023	0.017	0.201
Number of pods /plant	G	0.030	0.014	-0.022	-0.040	-0.089	0.973	0.195	0.016	-0.010	-0.196	-0.598	-0.001	-0.029	0.014	0.093
	P	-0.001	0.012	0.034	-0.016	0.191	-0.023	-0.003	-0.001	-0.020	-0.127	0.216	-0.001	-0.013	-0.006	0.081
Number of seeds/pods	G	-0.012	-0.003	0.024	0.145	0.081	-0.541	-0.090	0.002	0.008	0.237	0.004	0.275	0.010	-0.019	0.132
	P	-0.003	-0.001	-0.018	0.016	-0.043	0.015	0.002	0.001	0.022	0.094	0.001	0.020	0.004	0.006	0.060
Fruiting duration (days)	G	0.004	-0.001	0.115	0.364	0.066	-0.567	-0.485	-0.019	0.011	0.392	0.248	0.020	0.089	-0.027	0.171
	P	0.001	-0.004	-0.105	0.070	-0.059	0.016	0.015	0.006	0.031	0.201	-0.030	0.002	0.049	0.011	0.101
Protein % (green pod)	G	-0.007	-0.010	-0.131	-0.395	-0.221	0.947	0.426	-0.029	-0.015	-0.498	-0.183	-0.064	-0.040	0.076	-0.316
	P	-0.002	-0.008	0.107	-0.090	0.150	-0.028	-0.014	0.009	-0.047	-0.247	0.021	-0.003	-0.015	-0.035	-0.191
100 seed weight (g)	G	0.004	-0.004	0.096	0.430	0.088	-0.376	-0.351	0.037	0.017	0.612	-0.096	0.048	0.038	-0.032	0.377
	P	0.001	0.000	-0.076	0.076	-0.075	0.013	0.013	-0.004	0.062	0.473	0.026	0.004	0.023	0.016	0.318

G= Genotypic, P=Phenotypic, Residual effects:- G= 0.0564, P=0.1052

Table 5 : Genotypic and phenotypic path co-efficient analysis for green pod yield and its components in F₁ population of vegetable cowpea

Characters	G/P	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Plant height (cm)	G	-0.063	-0.014	0.018	-0.064	0.092	0.005	-0.207	0.290	-0.011	0.026	-0.011	0.019	0.006	-0.044	0.007
	P	-0.017	-0.001	0.022	-0.008	0.091	-0.046	-0.023	0.031	0.001	0.018	0.027	0.002	0.000	-0.003	0.031
Number of branches/ plant	G	0.004	0.052	-0.004	0.017	0.059	0.015	0.048	-0.048	0.002	0.042	-0.005	-0.001	-0.013	0.003	0.042
	P	0.003	-0.005	-0.004	0.002	0.067	-0.028	0.004	0.003	-0.002	0.039	0.113	0.001	0.001	0.002	0.070
Days to first flower	G	-0.024	-0.043	0.048	-0.197	0.115	0.020	-0.534	0.439	0.013	-0.263	-0.005	-0.009	0.235	-0.044	-0.172
	P	-0.026	-0.023	0.062	-0.027	0.118	-0.159	-0.062	0.041	-0.017	-0.173	0.047	-0.001	-0.001	-0.020	-0.142
Days to 50% flowering	G	-0.020	-0.032	0.047	-0.200	0.120	0.021	-0.561	0.439	0.014	-0.255	-0.010	-0.011	0.230	-0.023	-0.190
	P	-0.005	-0.010	0.061	-0.027	0.112	-0.164	-0.061	0.040	-0.017	-0.176	0.036	-0.001	-0.001	-0.019	-0.169
Number of flowers/cluster	G	-0.015	-0.034	0.014	-0.083	0.383	0.025	-0.212	0.137	0.012	-0.193	-0.021	-0.059	0.068	-0.028	-0.092
	P	-0.004	-0.012	0.017	-0.008	0.390	-0.203	-0.057	0.014	-0.014	-0.110	0.072	-0.034	-0.023	-0.034	-0.051
Number of pods/cluster	G	-0.008	-0.001	0.023	-0.099	0.232	0.041	-0.263	0.200	0.014	-0.174	-0.020	-0.021	0.115	-0.021	-0.065
	P	-0.002	-0.002	0.027	-0.012	0.271	-0.358	-0.027	0.020	-0.016	-0.128	0.176	-0.002	0.074	-0.016	-0.043
Days to first picking	G	-0.024	-0.012	0.047	-0.284	0.113	0.019	-0.546	0.464	0.013	-0.224	-0.005	-0.007	0.229	-0.022	-0.190
	P	-0.006	-0.008	0.061	-0.056	0.106	-0.152	-0.064	0.043	-0.016	-0.172	0.035	-0.001	-0.021	0.018	-0.156
Days to final picking	G	-0.028	-0.022	0.032	-0.135	0.080	0.013	-0.398	0.653	0.004	-0.044	0.001	-0.048	-0.074	-0.026	-0.074
	P	-0.008	-0.001	0.056	-0.016	0.116	-0.102	-0.039	0.070	-0.004	-0.031	0.036	-0.009	0.001	-0.011	-0.013
Pod length (cm)	G	-0.003	0.004	-0.022	0.097	-0.157	-0.020	0.269	-0.090	-0.029	0.392	0.055	0.029	-0.190	0.021	0.234
	P	-0.001	0.001	-0.028	0.043	-0.142	0.183	0.048	-0.008	0.037	0.298	-0.094	0.003	0.001	0.017	0.184
Pod weight (g)	G	-0.004	-0.008	-0.025	0.113	-0.108	-0.017	0.296	-0.066	-0.024	0.436	0.018	0.026	-0.236	0.020	0.239
	P	-0.001	-0.001	-0.031	0.034	-0.101	0.132	0.051	-0.006	0.050	0.349	-0.098	0.012	0.011	0.016	0.196
Number of pods /plant	G	-0.001	0.012	0.006	-0.026	0.148	0.340	-0.065	-0.011	0.011	-0.161	-0.042	0.005	0.076	-0.007	0.058
	P	-0.002	-0.001	0.010	-0.004	0.129	-0.160	-0.008	0.038	-0.012	-0.122	0.282	0.085	0.023	-0.006	0.113
Number of seeds/pods	G	-0.015	0.010	-0.005	0.035	-0.042	-0.010	0.049	-0.062	-0.010	0.155	-0.003	0.083	-0.005	0.008	0.084
	P	-0.003	-0.010	-0.005	0.003	-0.017	0.063	0.005	-0.003	0.010	0.081	0.021	0.010	-0.001	0.005	0.072
Fruiting duration (days)	G	0.001	0.010	-0.028	0.118	-0.064	-0.012	0.337	0.118	-0.013	0.253	0.008	0.001	-0.407	0.014	0.181
	P	0.001	0.007	-0.029	0.012	-0.036	0.072	0.069	0.021	0.014	0.160	-0.025	0.001	0.003	0.009	0.146
Protein % (green pod)	G	-0.006	0.012	0.031	-0.225	0.183	0.023	-0.343	0.251	0.016	-0.283	-0.008	-0.018	0.148	-0.037	-0.164
	P	-0.002	0.008	0.037	-0.036	0.161	-0.168	-0.045	0.023	-0.019	-0.195	0.051	-0.002	-0.001	-0.033	-0.143
100 seed weight (g)	G	-0.001	0.022	-0.026	0.151	-0.090	-0.009	0.443	-0.137	-0.018	0.357	-0.008	0.033	-0.214	0.070	0.307
	P	-0.002	-0.001	-0.029	0.084	-0.062	0.048	0.081	-0.003	0.021	0.273	0.073	0.022	0.001	0.037	0.321

G= Genotypic, P=Phenotypic, Residual effects:- G= 0.0669, P=0.1085

Table 6 : Genotypic and phenotypic path co-efficient analysis for green pod yield and its components in F₂ population of vegetable cowpea

Characters	G/P	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Plant height (cm)	G	0.325	-0.246	0.012	0.001	-0.009	-0.026	-0.016	-1.101	0.108	0.321	-0.026	0.020	0.952	0.023	0.020
	P	0.067	-0.006	-0.687	0.018	-0.011	-0.009	0.037	0.002	-0.026	0.230	-0.020	0.002	0.726	-0.004	0.005
Number of branches/ plant	G	-0.251	0.349	0.166	0.126	-0.011	-0.022	0.001	0.734	-0.202	-0.359	0.008	-0.022	-0.801	-0.114	-0.105
	P	-0.056	0.012	0.486	0.006	-0.012	-0.010	0.084	0.001	0.055	-0.299	0.021	-0.004	-0.640	0.037	-0.048
Days to first flower	G	0.007	0.107	0.541	0.364	-0.007	-0.050	0.008	0.139	-0.282	-0.378	-0.015	-0.044	-0.523	-0.163	-0.192
	P	0.002	0.002	0.072	0.026	-0.006	-0.047	0.472	0.001	0.073	-0.351	-0.060	-0.006	-0.592	0.033	-0.066
Days to 50% flowering	G	0.001	0.098	0.527	0.377	-0.009	-0.045	0.003	-0.048	-0.232	-0.336	-0.002	-0.042	-0.408	-0.113	-0.136
	P	0.001	0.003	-0.038	0.028	-0.010	-0.024	0.393	0.001	0.060	-0.297	-0.022	-0.007	-0.393	0.035	-0.079
Number of flowers/cluster	G	-0.047	-0.059	-0.056	-0.054	0.058	-0.034	0.000	0.545	0.003	0.055	0.004	0.003	-0.394	0.053	0.020
	P	-0.009	-0.002	0.371	-0.004	0.078	-0.019	-0.050	0.001	0.000	0.034	0.012	0.001	-0.311	-0.015	0.006
Number of pods/cluster	G	0.054	0.080	0.281	0.174	0.120	-0.097	0.002	0.091	-0.155	-0.088	-0.004	-0.039	-0.340	-0.090	-0.075
	P	0.010	0.002	0.058	0.011	0.026	-0.059	0.196	0.001	0.041	-0.061	-0.013	-0.016	-0.267	0.025	-0.040
Days to first picking	G	0.014	0.151	0.585	0.381	-0.009	-0.049	0.003	0.078	-0.316	-0.402	-0.017	-0.042	-0.534	-0.150	-0.183
	P	0.003	0.002	0.030	0.026	-0.009	-0.046	0.442	0.001	0.077	-0.332	-0.068	-0.016	-0.529	0.042	-0.066
Days to final picking	G	0.250	-0.194	-0.075	0.013	-0.042	0.006	-0.010	-1.375	0.110	0.244	-0.015	-0.007	1.251	0.051	0.038
	P	0.046	-0.006	-0.922	0.001	-0.029	0.003	-0.013	0.004	-0.038	0.173	-0.013	-0.001	1.032	-0.016	0.013
Pod length (cm)	G	0.076	-0.177	-0.397	-0.244	-0.345	0.033	-0.002	-0.327	0.465	0.481	0.044	0.458	0.460	0.160	0.215
	P	0.034	-0.005	-0.212	-0.015	0.018	0.029	-0.263	0.000	-0.130	0.572	0.219	0.047	0.539	-0.040	0.097
Pod weight (g)	G	0.132	-0.219	-0.346	-0.193	0.004	0.011	-0.112	-0.484	0.408	0.756	0.037	0.036	0.592	0.142	0.202
	P	0.087	-0.005	-0.279	-0.013	0.005	0.006	-0.205	0.011	-0.106	0.574	0.187	0.016	0.629	-0.034	0.076
Number of pods /plant	G	-0.027	0.038	-0.110	-0.009	0.003	0.005	-0.001	0.101	0.283	0.387	0.073	0.012	0.023	0.061	0.129
	P	-0.005	0.001	0.052	-0.001	0.004	0.003	-0.084	0.001	-0.076	0.255	0.252	0.001	0.034	-0.021	0.027
Number of seeds/pods	G	0.100	-0.190	-0.426	-0.343	0.003	0.058	-0.052	0.132	0.305	0.422	0.017	0.065	0.207	0.104	0.114
	P	0.028	-0.004	0.068	-0.014	0.004	0.027	-0.176	0.013	-0.064	0.270	0.012	0.014	0.178	-0.024	0.035
Fruiting duration (days)	G	0.212	-0.237	-0.288	-0.151	-0.017	0.014	-0.001	-1.289	0.214	0.348	0.001	0.010	1.367	0.105	0.115
	P	0.081	-0.006	-0.897	-0.008	-0.022	0.013	-0.178	0.012	-0.059	0.297	0.008	0.002	1.127	-0.021	0.040
Protein % (green pod)	G	-0.037	0.251	0.475	0.259	-0.014	-0.043	0.052	0.385	-0.345	-0.506	-0.022	-0.033	-0.687	-0.203	-0.211
	P	-0.014	0.006	0.217	0.015	-0.018	-0.032	0.243	0.001	0.079	-0.418	-0.092	-0.015	-0.584	0.065	-0.092
100 seed weight (g)	G	0.017	-0.192	-0.480	-0.293	0.005	0.028	-0.052	-0.293	0.392	0.609	0.034	0.028	0.609	0.175	0.242
	P	0.005	-0.004	-0.139	-0.015	0.007	0.017	-0.268	0.015	-0.099	0.532	0.165	0.015	0.582	-0.047	0.068

G= Genotypic, P=Phenotypic, Residual effects:- G= 0.0071, P=0.0143

with 100 seed weight and green pod yield per plant, number of pods per cluster with days to first picking and per cent protein content in green pods, number of seed per pod with 100 seed weight, number of pickings and green pod yield per plant at both phenotypic and genotypic levels. The above findings are in agreement with Chattopadhyay *et al.* (1997); Vardhan and Savithamma (1998); Vidya and Oommen (2002); Kutty *et al.* (2003); Sapara and Javia (2014); Venkatesan *et al.* (2003) and Lovely and Radhadevi (2006).

The result of correlation Table 3 study in all three generations showed that green pod yield per plant had significant and positive correlation with number of pods per plant, pod length and pod weight. Similarly significant and positive correlation with pod length with pod weight and 100 seed weight, pod weight with fruiting duration and 100 seed weight, number of pods per cluster with days to first fruiting and per cent protein content in green pods, days to first flower with days to 50 per cent flower and days to first picking in base, F_1 and F_2 generations. The consistency in correlation in normal self pollinated progenies and inter-mated populations *i.e.*, F_1 and F_2 generations indicated that the existence of strong linkage among these characters. On other hand remarkable positive association was arised between green pod yield with number of seeds per pod and fruiting duration, fruiting duration with plant height, number of seeds per pod with pod length and pod weight, etc. Similarly, association between number of pods per plant with pod length and pod weight were negative in parent, which becomes positive and significant in F_1 and F_2 generations. This correlation arises due to linkage or pleiotropism or from the developmental genetic interactions with or without purely phenotypic components. In inter-mated generations, linkages and broken and new associations were formed. As such, the direction and magnitude of the character associations would differ in normal self progeny from those in inter-mated population. The result reveals that associations among important characters can be altered by restoring to inter-mating. However, the direction of change would depend on the initial constitution of parent population and selection history. The initial linkages between characters also affect the result of inter-mating because by random mating correlation co-efficients would increase if the initial linkage was in repulsion phase and *vice-versa* if it was in coupling phase (Singh *et al.*, 1997; Hirenkumar *et al.*, 2011; Chavan and Khafi, 2013 and Yadav *et al.*,

2003).

In base population, number of pods per cluster expressed a highest positive direct effect on green pod yield per plant followed by number of nodes per plant, days to first picking, pod weight, 100 seed weight whereas, lowest positive direct effect on green pod yield per plant was observed for pod length which is indirectly contributing through pod weight, number of pods per plant and 100 seed weight (Table 4). The direct effects of number of pods per plant, days to first flower and days to 50 per cent flowering were negative, but these characters contributed indirectly via number of pods per cluster and days to first picking. In F_1 generation, days to final picking, pod weight, number of flowers per cluster and 100 seed weight contributed maximum directly towards green pod yield per plant (Table 5). The direct effects of pod length, number of pods per plant and days to 50 per cent flowering were negative, but these characters contributed indirectly via days to final picking, pod weight, number of pods per cluster and days to first picking. In segregating population *i.e.*, F_2 the path co-efficient analysis revealed that fruiting duration expressed a highest positive direct effect on green pod yield per plant followed by pod weight, days to first flowering, pod length, days to 50 per cent flowering, number of branches per plant, plant height, 100 seed weight, number of pods per plant (Table 6). Similar findings were also reported by Chattopadhyay *et al.* (1997); Kutty *et al.* (2003); Yadav *et al.* (2003); Anuja and Vijayalakshmi (2013) and Lovely and Radhadevi (2006). The direct effects of number of pods per cluster and days to final picking were negative, but these characters contributed indirectly via days to first flowering and days to 50 per cent flowering and fruiting duration, plant height and pod weigh. The variation in direction and magnitude of direct and indirect effects of different characters in three sets of analysis may be due to differences in genetic constitution of genotypes in the populations (Yadav *et al.*, 2003).

An over all conclusion on correlation and path analysis revealed that 100 seed weight, pod weight, pod length and number of pods per plant are major components of green pod yield in early generations of cowpea. Hence, the direct selection in form of selection indices based on these component characters would be effective in development of high yielding genotypes of vegetable cowpea.

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