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A Path Coefficient Analysis For Growth, Yield and Yield Components in Vegetable Cowpea (*Vigna unguiculata* L. Walp)

Madhavi K.*, Sivaji T.* and Amrutha N.*

ABSTRACT: *Path analysis study was conducted with nine vegetable cowpea varieties and fifteen component characters are taken into consideration. The results revealed significant direct positive effect of plant height, dry matter, pod yield per plant, days to first flowering, Days to first picking, Pod length, mean pod weight for pods per plant Hence selection based on these traits would be effective in increasing the seed yield.*

Key words: *Cowpea, path analysis, pod yield.*

INTRODUCTION

Cowpea (*Vigna unguiculata* (L.) Walp.) is one of the most important food legumes which serve as vital source of protein in the diet of the people of developing countries. It is widely grown in the third world for its cheap source of dietary protein (Ibrahim *et al*., 2010). Cowpea has considerable adaptation to high temperatures and drought compared to other crop species, but is intolerant of frost. Cowpea is usually better adapted to drought, high temperatures and other biotic stresses than other crop plant species (Ehlers and Hall, 1997). It is primarily grown in drier regions of the world where it is one of the most drought-resistant food legumes (Dadson *et al*., 2005).

Cowpea yields have been low compared to in experimental plots. Part of the reason for this low yield have been attributed to insect pests and diseases, use of low yielding varieties and plant population density.

Selection of high yielding crops with wider adaptability shall not be only very useful but shall induce increasing productivity. Genetic improvements of pod yield alone is not possible through phenotypic selection because of polygenic nature and low heritability. Hence selection through correlation response entailing several contributing factors which influence pod production both directly and indirectly shall be most appropriate. Therefore, an understanding of relationship between yield and its components is fundamental for selection process and its relationship can be explained by means of path analysis. Path coefficient analysis provides a more realistic understanding of the relationship as it partitions the correlation coefficient into the direct as well as the indirect effects of the variables. Path analysis provides information on the path through which the component characters influences the expression of an economic character like yield and have been used extensively in the improvement of many crops by many workers. The present experiment was conducted to study direct and indirect contributions of some yield contributing characters towards pod yield of some cowpea varieties.

MATERIALS AND METHODS

A field experiment entitled "Evaluation of vegetable cowpea (*Vigna unguiculata* L. Walp*)* varieties for high yield in coastal Andhra Pradesh" was carried out during 2011 at Horticultural college and Research Institute, Dr. Y. S. R. Horticultural University, Venkataramannagudem, West Godavari District. The experiment was arranged in a randomized block design (RBD) with 3 replications. The experiment was arranged in a randomized block design (RBD) with 3 replications. The nine varieties viz., Arka Garima (T1),

* Horticultural College and Research Institute, Dr. Y. S. R. Horticultural University, Venkatarammanagudem, *E-mail: madhavikaranki17@gmail.com*

Arka Suman (T2), Bhagya Lakshmi (T3), Vellayani Local (T4), Khashi Kanchan (T5), Baramasi (T6), Gomthi (T7), Pusa Komal (T8) and local check (T9) were assessed for different growth and yield attributing characters in the field.

The land was prepared into plots of size 3.0 m x 2.7 m and the seeds were directly dibbled 5 cm deep on ridges adopting a uniform spacing of 60 cm between the rows and 30 cm within the row. Before sowing, farm yard manure was applied to the soil as a basal dose as per the recommendation. Nitrogen was applied in the form of urea (46% N) @ 25 kg ha-1 in two equal splits *ie*., as a basal dose and subsequent dose at flowering stage by placement method. Phosphorous was applied in the form of single superphosphate (16% P2O5) and Potassium was in the form of Muriate of potash (MOP) (58-62%K2O). Both phosphorus and potash were applied completely as a basal dressing @ 50 kg ha-1. Irrigations were given at 5 days interval depending upon moisture condition of experimental plot, to maintain uniform soil moisture throughout the crop growth period. Hand weeding was done at 15 and 30 days after germination. The crop was duly protected from pests by fortnightly spraying of Carbaryl (3g l^{-1}) for controlling of sucking pests, Endosulphon (2 ml l^{-1}) and Malathion (2 ml l^{-1}) were used for the control of pod borers.

Five plants in each plot were tagged from the net plot of each treatment in each replication for recording the observations. The observations on plant height, number of primary branches, number of leaves, dry matter accumulation per plant, days to first flowering, days to 50 per cent flowering, crop duration, pod length, pod girth, seeds per pod, pods per plant, individual pod weight, test weight and pod yield per plant were recorded.

Path coefficient analysis was carried out using phenotypic correlation values of yield components on yield as suggested by Wright (1921) and illustrated by Dewey and Lu (1959). Standard path coefficients which are the standardized partial regressing coefficients were obtained using statistical software packages called GENRES. These values were obtained by solving the following set of 'p' simultaneous equation using the above package.

$$P_{01} + P_{02}\, r_{12} + \text{— — — —} + P_{0P} r_{1P} = r_{01}$$
$$P_{02}\, r_{21} + P_{02} + \text{— — — —} + P_{0P} r_{2P} = r_{02}$$

$$\downarrow$$

$$P_{01} r_{P1} + P_{02}\, r_{2P} + \text{— — — —} + P_{0P} = r_{0P}$$

Where, $P_{01}, P_{02}, \_\_\_\_\_ P_{0P}$ are the direct effects of variables 1,2, — — — — p on the dependent variable 0 / $r_{12}, r_{13}, -$ — — — — — — r_{1P} — — — — $r_{P(P-1)}$ are the possible correlation coefficients between various independent variables / r_{01}, r_{02}, r_{03} — — r_{0P} are the correlation between dependent and independent variables.

The indirect effects of the i^{th} variable *via* j^{th} variable is attained as $P_{oj} \times r_{ij}$. The contribution of remaining unknown factor is measured as the residual factor, which is calculated and given below.

$$P^2ox = 1-[P^2_{01} + 2P_{01}P_{02}r_{-12} + 2P_{01}P_{03}r_{13} + \text{— — — — — —} + P^2_{02} + 2P_{02}P_{03}r_{13} + \text{— — — —} + P^2_{0P}]$$

Residual factor = $\sqrt{(P^2_{ox})}$

Direct or indirect effects were categorized as suggested by Lenka and Mishra (1973) are given below:

Negligible	- 0.00 to 0.09;
Low	- 0.10 to 0.19;
Moderate	- 0.20 to 0.29;
High	- 0.30 to 0.99 and
Very high	- 1.00.

RESULTS AND DISCUSSION

The direct and indirect effects of the growth and yield components on the yield of 9 cowpea varieties is shown in the table 1 and the results are discussed here under.

The study of direct effect showed that plant height, dry matter, days to first flowering, days to first picking, pod length and mean pod weight exhibited considerable positive effects on pod yield per plant whereas negative effects on yield were observed with number of primary branches, number of leaves, days to 50 per cent flowering, crop duration, pod girth, pods per plant, seeds per pod and test weight.

Plant height had direct positive effect on pod yield and positive indirect effect via pod yield through high dry matter accumulation, days to 50 per cent flowering, high pod length and mean pod weight. Similar results were reported by Jana *et al.* (1983) in cowpea.

Number of primary branches showed negative direct effect on yield but showed more indirect positive effect by dry matter accumulation, pod length and pod weight. Similar results reported by Satyawan Arya *et al.* (2004) in peas.

Table 1
Genotypic Path Coefficient Analysis

Character	*Plant Height Final harvest*	*Primary Branches Final harvest*	*Dry Matter Final harvest*	*Leaves Final harvest*	*Days to 1st Flowe-ring*	*Days to 50% Flowe-ring*	*Days to First Picking*	*Crop Duration*	*Pod Length (cm)*	*Pod Girth (cm)*	*Pods/ Plant*	*Mean Pod Weight (g)*	*Seeds/ Pod*	*Test Weight*
Plant Height Final harvest	**0.5735**	0.4348	0.4735	0.5339	-0.1966	-0.1780	-0.4256	0.5166	0.3503	0.2046	0.4801	0.2646	0.4198	0.2295
Primary Branches Final harvest	-0.2965	**-0.3910**	-0.3480	-0.3656	0.3186	0.2392	0.3868	-0.3555	-0.3552	-0.2286	-0.3508	-0.2226	-0.3412	-0.2320
Dry Matter Final harvest	4.3841	4.7247	**5.3098**	4.3152	-1.9328	-1.8921	-3.4372	5.0960	3.4965	2.6928	3.9917	2.2014	3.5748	2.9378
Leaves Final harvest	-3.2020	-3.2152	-2.7949	**-3.4391**	2.1159	1.5932	2.9074	-3.0528	-2.6831	-1.2701	-3.0618	-1.5250	-2.6811	-1.4789
Days to 1st Flowering	-1.0489	-2.4932	-1.1138	-1.8825	**3.0598**	1.6267	2.9180	-1.3282	-2.5043	-1.9242	-1.3848	-1.9612	-2.2782	-1.3217
Days to 50% Flowering	1.1151	2.1973	1.2802	1.6643	-1.9100	**-3.5926**	-1.1183	0.4577	2.6874	1.6065	0.7370	1.9395	2.3358	3.0741
Days to First Picking	-0.4813	-0.6415	-0.4198	-0.5482	0.6184	0.2018	**0.6485**	-0.5264	-0.5443	-0.5321	-0.4511	-0.5393	-0.6112	-0.2725
Crop Duration	-1.0595	-1.0693	-1.1288	-1.0440	0.5105	0.1498	0.9547	**-1.1761**	-0.7860	-0.4759	-1.0385	-0.4722	-0.8610	-0.4283
Pod Length(cm)	4.9341	7.3368	5.3192	6.3020	-6.6112	-6.0424	-6.7807	5.3986	**8.0778**	5.0198	3.9779	5.6441	7.4699	6.3361
Pod Girth(cm)	-0.4382	-0.7179	-0.6229	-0.4536	0.7724	0.5493	1.0079	-0.4970	-0.7633	**-1.2283**	-0.2226	-1.1188	-0.9613	-0.8339
Pods/ Plant	-0.3802	-0.4074	-0.3414	-0.4043	0.2055	0.0932	0.3159	-0.4010	-0.2236	-0.0823	**-0.4541**	-0.1092	-0.2401	-0.0584
Mean Pod Weight(g)	3.0673	3.7840	2.7565	2.9482	-4.2615	-3.5893	-5.5299	2.6692	4.6455	6.0558	1.5994	**6.6487**	5.9809	4.8332
Seeds/ Pod	-2.5580	-3.0489	-2.3527	-2.7244	2.6019	2.2721	3.2937	-2.5583	-3.2316	-2.7348	-1.8477	-3.1436	**-3.4946**	-2.7447
Test Weight	-3.7542	-5.5671	-5.1909	-4.0345	4.0527	8.0280	3.9425	-3.4162	-7.3592	-6.3694	-1.2058	-6.8202	-7.3688	**-9.3821**
Pod Yield/ Plant (g)	0.8554	0.9261	0.8262	0.8674	-0.6563	-0.5411	-0.9163	0.8267	0.8070	0.7338	0.7688	0.7861	0.9439	0.6582
Partial R^2	0.4906	-0.3621	4.3870	-2.9830	-2.0080	1.9440	-0.5942	-0.9723	6.5185	-0.9013	-0.3491	5.2263	-3.2986	-6.1753

R SQUARE = 0.9223 RESIDUAL EFFECT = 0.2788

Number of leaves per plant showed direct negative effect on pod yield but contributed high indirect positive effect through dry matter, days to 50 per cent flowering, pod length and pod weight.

Dry matter also showed high direct effect on pod yield per plant with maximum indirect effect through pod length followed by pod weight.

On pod yield per plant, days to first flowering showed direct positive effect and seeds per pod and test weight showed indirect effect. Similar results reported by Jana *et al.* (1983) in cowpea and Bendale *et al.* (2008) in lab lab bean.

Days to 50 per cent flowering showed direct negative effect and indirect positive effect through number of leaves, days to first flowering, seeds per pod and test weight on pod yield per plant.

Days to first picking has direct positive effect on pod yield maximum indirect positive effect through test weight, seeds per pod followed by number of leaves and days to first flowering. Similar results reported by Muhmmad Arshad *et al.* (2006) and Bendale *et al.* (2008) in lab lab bean.

Crop duration showed direct negative effect on pod yield but showed more positive indirect effect through dry matter accumulation, pod length and pod weight.

Pod length showed maximum positive direct effect on pod yield per plant and indirect effect through pod weight. Similar results reported by Muhmmad Arshad *et al.* (2006) and Anjani Kumar Singh (2009).

Pod girth showed negative direct effect on pod yield but showed maximum indirect positive effect through pod length and pod weight.

Pods per plant showed direct negative effect on pod yield but showed indirect positive effect through dry matter, pod length and pod weight. Similar result reported by Harshal (2006), but high direct positive effect of pods per plant on pod yield was reported by Jana *et al.* (1983), Chattopadhya *et al.* (1996) in cowpea; Resmi (1998) in yard long bean and Satyawan Arya *et al.* (2004) in peas which are contradictory to the present results.

Mean pod weight showed maximum direct positive effect on pod yield per plant and indirect effect through pod length. Similar results reported by Sobha (1994) and Chattopadhya *et al.* (1997) in vegetable cowpea.

Seeds per pod showed negative direct effect on pod yield per plant whereas showed positive indirect effect through pod length and pod weight. But positive direct effect on yield was reported by Jana *et al.* (1983), Patil *et al.* (1989) and Harshal (2006) in cowpea.

Test weight showed maximum negative direct effect on pod yield but showed indirect positive effect through dry matter, days to 50 per cent flowering, pod length and pod weight. Satyawan Arya *et al.* (2004) in peas; Harshal (2006) in cowpea; Muhmmad Arshad *et al.* (2006) reported positive direct effect which is contradictory to the results obtained.

The research results revealed that much emphasis should be given on pod length and pod weight apart from plant height, dry matter accumulation and days to first flowering for selecting a high yielding variety in cowpea.

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