

Original Research Article

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Correlation and Path Coefficient Analysis for Yield and Yield Attributes in Cluster Bean [*Cyamopsis tetragonoloba* (L.) Taub.] Genotypes

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ABSTRACT

Forty five cluster bean genotypes (*Cyamopsis tetragonoloba* (L.) Taub) were evaluated to find out the correlation and path analysis for vegetable pod yield and yield attributes during *khariif* 2018 at College of Horticulture, Anantharajupeta, Andhra Pradesh. Character association of the yield attributing traits revealed that fresh pod yield per plant had highly significant and positive association with pod length, number of pods per plant, number of pods per cluster, number of pod clusters per plant and number of branches per plant at maturity. Direct selection based on these traits could result in simultaneous improvement of afore said traits and marketable pod yield in cluster bean. From path analysis, it can be inferred that very high positive direct effect on fresh pod yield per plant was exerted by number of clusters per pod at genotypic levels while pod length, number of pod clusters per plant, number of pods per plant and number of clusters per plant exerted a positive and high direct effect on fresh pod yield per plant at both genotypic and phenotypic levels. High negative direct effect on fresh pod yield per plant was exerted by days to first flowering and days to 50 % flowering. High direct effect of these traits appeared to be the main factor for their strong association with pod yield per plant. Hence direct selection for these traits would be highly effective in improving the pod yield per plant.

Keywords

Cluster bean,
Correlation, Path
coefficient analysis,
Vegetative
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Introduction

Cluster bean ($2n=2x=14$) commonly known as guar, is an important self-pollinated leguminous crop belong to family Leguminaceae. Guar is a crop of arid and semi arid tropical areas spread over the North and North Western part of India requiring low inputs and care. Guar is mainly cultivated for food as vegetable, feed and fodder (Pawan

kumar *et al.*, 2017). It is cultivated mainly in rainy season as a rainfed crop in arid zones of India and various other parts of the world (Pathak *et al.*, 2009). The crop is mainly grown in the dry habitats of Rajasthan, Haryana, Gujarat and Punjab and to a limited extent in Uttar Pradesh, Madhya Pradesh, Andhra Pradesh, Tamil Nadu, Karnataka and Kerala.

In spite of the importance of this crop in agricultural production, productivity of this crop is very low in India due to lack of suitable high yielding varieties, rainfed cultivation, improper time of sowing, pests and diseases incidence, inadequate fertilization and improper agronomic practices. Therefore, there is an urgent need to design breeding programmes that can enhance productivity and stabilize the yield.

Yield, being a complex trait, is composed of several components some of which affect the yield directly while, others affect indirectly. Hence knowledge of association between yield and its components is necessary. Correlation studies would provide estimates of degree of association between seed yield and its components and also among the components. While path co-efficient analysis further elucidates the intrinsic nature of association of component traits by determining direct or indirect contribution of these traits to yield.

Materials and Methods

A field experiment was conducted at Vegetables block, College of Horticulture, Anantharajupeta, YSR Kadapa (Dt), Dr. Y. S. R. Horticultural University, Andhra Pradesh during *kharif* 2018. Cluster bean germplasm comprising of 45 genotypes (Table 1) (including check varieties Pusa Navbahar and MDU-1) were collected from different geographical regions were evaluated in a randomized complete block design (RCBD) with three replications. Each genotype was sown in double row plot of 4 m row length. Row to row and plant to plant distances were maintained as 40 cm and 30 cm, respectively. Uniform recommended package of practices were adopted to raise a good crop. Observations were recorded on five randomly selected plants in each from each replication. The observations on plant height at 30 days (cm), plant height at harvest (cm), number of

branches per plant, days to first flowering, days to 50% flowering, days to pod maturity, pod length (cm), pod thickness (mm), pod width (mm), number of pods per cluster, number of clusters per plant, number of pods per plant, number of seeds per pod, pod yield per plant (g), pod yield (t/ha) 100 seed weight, protein content (%) and gum content(%).

Genotypic and phenotypic correlation coefficient was calculated by using the method given by Johnson *et al.*, (1955). The genotypic and phenotypic correlation coefficients were used in finding out their direct and indirect contribution towards yield per plot. The path coefficient analysis was carried out by the method suggested by Dewey and Lu (1959) to partition the genotypic correlation coefficients into measures of direct and indirect effects.

Results and Discussion

Selection based on the detailed knowledge of magnitude and direction of association between yield and its attributes is very important in identifying the key characters, which can be exploited for crop improvement through suitable breeding programme. The estimates of correlation coefficients are presented in Table 2 and 3. In general genotypic correlation coefficients were higher than phenotypic correlation coefficient for all the characters under study.

Number of clusters per plant showed highly significant and positive correlation with number of branches per plant at maturity at both phenotypic and genotypic level. Similar results were reported by Saini *et al.*, (2010) and Girish *et al.*, (2012). This indicates there is a strong association of this trait to the total yield through the number of clusters per plant. Hence, more branches per plant indirectly resulted into higher yield.

Pod yield per plant exhibited highly significant positive association with pod length, number of pods per plant, number of pods per cluster, number of clusters per plant and number of branches per plant at maturity. These results are in agreement with Anandhi and Oommen (2010), Rai and Dharmatti (2014), Kumar and Ram (2015) and Vir and Singh (2015) for number of pods per plant ; Rai and Dharmatti (2014), Girish *et al.*, (2012), Kastoori *et al.*, (2009), Patil (2014) for number of clusters per plant. Days to pod maturity showed significant negative association with pod yield per plant and these results are in agreement with Patil (2014).

Present results indicate the importance of these traits in selection for marketable pod yield per plant. Direct selection based on these traits would result in simultaneous

improvement of afore said traits and yield in cluster bean. Thus, the pod length and number of pods per plant seems to have predominant effect on pod yield per plant. Hence, there is an ample scope in the improvement of yield by selecting a genotype having higher pod length and number of pods per plant since they are highly correlated.

The results on character association indicated significant positive association of yield with pod length, number of clusters per plant, number of pods per plant and pod yield per hectare which indicated that the adequate knowledge of interrelationship between marketable pod yield per plant and its components themselves is useful for selection and simultaneous improvement for these characters (Fig. 1).

Table.1 Source and place of collection used in the study of Cluster bean genotypes

Source	Number of genotypes	Genotypes
ARS, Durgapur, Rajasthan	18	GP-1,GP-2,GP-3,GP-5,GP-6,GP-7, GP-8,GP-10,GP-11, GP-12,GP-13, GP-14,GP-15,GP-16,GP-17,GP-18, GP-19, GP-20.
NBPGR, Jodhpur, Rajasthan	25	IC-113272,IC-113278,IC-113281, IC-113308,IC113377,IC113390, IC-113393,IC-113394,IC-113396, IC-113499,IC-113506,IC113523, IC-113568,IC-116569,IC-116608,IC-116619, IC-116626,IC116652, IC-116660,IC-116705, IC-116779,IC-116825,IC-116925,IC116930, IC-116932.
AAU, Anand, Gujarat	1	Pusa Navbahar
TNAU, Coimbatore, Tamilnadu	1	MDU-1

Table.2 Phenotypic correlation matrix for different characters among forty five cluster bean genotypes

	PH30D	PHH	DFF	D50F	PT	PL	PW	NPP	NPC	NCP	NBPM	NSP	100SW	DPM	PC	GC
PH30D	1.0000															
PHH	0.3777**	1.0000														
DFF	-0.3310**	0.1803*	1.0000													
D50F	-0.3134**	0.2216**	0.9872**	1.0000												
PT	-0.0633	0.0305	-0.0749	-0.0358	1.0000											
PL	-0.1995*	0.1258	-0.0117	-0.0122	0.4999	1.0000										
PW	-0.1610	0.4464**	-0.3771**	-0.4135**	0.4922**	0.5439**	1.0000									
NPP	0.2058*	-0.0162	-0.0275	-0.0181	-0.3665**	-0.3305**	-0.2646**	1.0000								
NPC	0.0493	-0.0775	-0.0356	-0.0351	0.2690**	0.2201*	0.1106	0.2299**	1.0000							
NCP	0.0197	-0.1183	0.0030	-0.0006	0.2212**	0.1984*	0.0917	0.2976**	0.9367**	1.0000						
NBPM	0.2392**	0.0159	-0.1497	-0.1424	-0.2644**	-0.3996**	-0.2000*	0.4337**	0.1727*	0.2159*	1.0000					
NSP	-0.0432	-0.0780	-0.0256	-0.0105	0.2344**	0.5924**	0.3370**	-0.2111*	0.1561	0.1629	-0.2816**	1.0000				
100SW	0.0197	-0.0074	-0.1663	-0.1543	0.3016**	0.2242**	0.2125*	-0.1067	0.0928	0.0812	0.0932	0.1440	1.0000			
DPM	0.1201	0.0095	-0.0697	-0.0627	0.0769	0.2127*	0.0548	-0.0599	0.1307	0.1741*	-0.0148	0.0169	-0.1380	1.0000		
PC	0.1961**	0.0644	-0.1679	-0.1821*	-0.0878	0.0898	0.0379	-0.0189	-0.1231	-0.1977*	0.1776*	0.1845*	0.0712	0.1182	1.0000	
GC	-0.0606	0.1208	0.2065*	0.1915*	-0.2090*	-0.2172*	0.0892	0.0913	-0.0288	-0.0083	0.3381**	-0.2270**	-0.2256**	0.2488**	0.1701*	1.0000
PYPP	0.0959	-0.0144	-0.0062	-0.0021	0.1273	0.2287**	0.1418	0.3829**	0.5671**	0.6050**	0.2525**	0.2149*	0.0597	-0.0139**	0.0557	0.0129

*Significant at 5 per cent level;

** Significant at 1 per cent level

PH30: Plant height at 30 days

PHH: Plant height at harvest

DFF: Days to first flowering

D50F: Days to 50% flowering

PT: Pod

thickness (mm) PL: Pod length (cm)

PW: Pod width (mm)

NPP: Number of pods per plant

NPC: Number of pods per cluster

NCP:

Number of clusters per plant NBPM: Number of branches per plant at maturity

NSP: Number of seeds per pod

100SW: 100 Seed weight

DPM: Days to pod maturity PC: Protein content (%)

GC: Gum content (%)

PYPP: Pod yield per plant (g)

Table.3 Genotypic correlation matrix for different characters among forty five cluster bean genotypes

	PH30D	PHH	DFF	D50F	PT	PL	PW	NPP	NPC	NCP	NBPM	NSP	100SW	DPM	PC	GC
PH30D	1.0000															
PHH	0.9203**	1.0000														
DFF	-0.6067**	-0.6775**	1.0000													
D50F	-0.6065**	-0.7199**	0.9837**	1.0000												
PT	-0.0482	-0.0466	-0.1547	-0.1129	1.0000											
PL	-0.4134**	-0.2759**	-0.0257	-0.0284	0.5964**	1.0000										
PW	0.3465**	0.2169*	-0.3645**	-0.3309**	0.1818**	-0.0547	1.0000									
NPP	0.1904*	-0.0339	-0.0735	-0.0535	-0.6956**	-0.7329**	0.2946**	1.0000								
NPC	0.0761	-0.1620	-0.0521	-0.0551	0.2975**	0.2442**	0.2893**	0.4082**	1.0000							
NCP	0.0219	-0.2676**	-0.0139	-0.0210	0.2501**	0.2277**	0.1282	0.5080**	0.9587**	1.0000						
NBPM	0.3200	-0.3163**	-0.3352**	-0.3573**	-0.3225**	-0.4604**	0.2462**	0.8295**	0.1774*	0.2222**	1.0000					
NSP	-0.1174	-0.1761*	-0.0422	-0.0254	0.2709**	0.6566**	0.0142	-0.4273**	0.1621	0.1685*	-0.3037**	1.0000				
100SW	0.1268	-0.0434	-0.2359**	-0.2305**	0.3770**	0.2523**	-0.5769**	-0.3621**	0.1112	0.0887	0.1085	0.1881*	1.0000			
DPM	0.1830*	-0.0173	-0.1017	-0.0982	0.0630	0.2383**	-0.1583	-0.1332	0.1409	0.1763*	-0.0215	0.0180	-0.1597	1.0000		
PC	0.2860	0.1191	-0.2052	-0.2339**	-0.0987	0.0990	-0.0530	-0.0332	-0.1242	-0.2026*	0.1826**	0.1893*	0.0811	0.1214	1.0000	
GC	0.0395	-0.7309**	0.0619	0.1446	-0.4710**	-0.3469**	-0.1367	0.5176**	-0.0664	-0.0117	0.4206**	-0.3782*	-0.3213**	0.3749**	0.2823**	1.0000
PYPP	-0.0614	-0.2587	-0.1186	-0.1261	0.1096	0.3054**	0.2204	0.7680**	0.7115**	0.7865**	0.2953**	0.2687**	0.0507	-0.0092**	0.0717	-0.1278

*Significant at 5 per cent level;

** Significant at 1 per cent level

PH30: Plant height at 30 days PHH: Plant height at harvest DFF: Days to first flowering D50F: Days to 50% flowering PT: Pod thickness (mm) PL: Pod length (cm) PW: Pod width (mm) NPP: Number of pods per plant NPC: Number of pods per cluster NCP: Number of clusters per plant NBPM: Number of branches per plant at maturity NSP: Number of seeds per pod 100SW: 100 Seed weight DPM: Days to pod maturity PC: Protein content (%) GC: Gum content (%) PYPP: Pod yield per plant (g)

Table.4 Phenotypic path coefficient analysis for different characters among forty five cluster bean genotypes

	PH30 D	PHH	DFF	D50F	PT	PL	PW	NPP	NPC	NCP	NBPM	NSP	100SW	DPM	PC	GC	PYPP
PH30D	0.0493	0.0186	-0.0163	-0.0155	-0.0031	-0.0098	0.0053	0.0102	0.0024	0.0010	0.0118	-0.0021	0.0045	0.0059	0.0097	-0.0030	0.0959
PHH	0.0164	0.0434	0.0078	0.0096	0.0013	-0.0055	0.0035	-0.0007	-0.0034	-0.0051	0.0007	-0.0034	-0.0003	0.0004	0.0028	0.0052	-0.0144
DFF	-0.0111	0.0060	-0.0335	0.0330	-0.0025	-0.0004	-0.0022	-0.0009	-0.0012	0.0001	-0.0050	-0.0009	-0.0056	-0.0023	-0.0056	0.0069	-0.0062
D50F	-0.0003	0.0002	0.0010	-0.0010	0.0000	0.0000	-0.0001	0.0000	0.0000	0.0000	-0.0001	0.0000	-0.0002	-0.0001	-0.0002	0.0002	-0.0021
PT	-0.0034	0.0016	-0.0040	-0.0019	0.0537	0.0268	0.0029	-0.0197	0.0144	0.0119	-0.0142	0.0126	0.0162	0.0041	-0.0047	-0.0112	0.1273
PL	-0.0549	-0.0346	-0.0032	-0.0033	0.1375	0.2751	-0.0133	-0.0909	0.0606	0.0546	-0.1099	0.1630	0.0617	0.0585	0.0247	-0.0597	0.2287
PW	0.0098	0.0074	-0.0061	-0.0047	0.0049	-0.0044	0.0912	0.0076	0.0080	0.0032	0.0088	-0.0032	-0.0142	-0.0021	-0.0019	0.0031	0.1418
NPP	0.0564	-0.0044	-0.0075	-0.0050	-0.1005	-0.0906	0.0230	0.2741	0.0630	0.0816	0.1189	-0.0578	-0.0292	-0.0164	-0.0052	0.0250	0.3829
NPC	-0.0052	0.0082	0.0037	0.0037	-0.0283	-0.0232	-0.0092	-0.0242	-0.1053	-0.0986	-0.0182	-0.0164	-0.0098	-0.0138	0.0130	0.0030	0.5671
NCP	0.0113	-0.0678	0.0017	-0.0003	0.1269	0.1138	0.0204	0.1707	0.5373	0.5736	0.1238	0.0934	0.0466	0.0999	-0.1134	-0.0047	0.6050
NBPM	0.0302	0.0020	-0.0189	-0.0180	-0.0334	-0.0504	0.0122	0.0547	0.0218	0.0272	0.1261	-0.0355	0.0118	-0.0019	0.0224	0.0426	0.2525
NSP	-0.0025	-0.0046	-0.0015	-0.0006	0.0137	0.0346	-0.0020	-0.0123	0.0091	0.0095	-0.0164	0.0583	0.0084	0.0010	0.0108	-0.0132	0.2149
100SW	-0.0049	0.0004	0.0090	0.0083	-0.0162	-0.0121	0.0084	0.0057	-0.0050	-0.0044	-0.0050	-0.0078	-0.0538	0.0074	-0.0038	0.0121	0.0597
DPM	-0.0176	-0.0014	0.0102	0.0092	-0.0113	-0.0312	0.0034	0.0088	-0.0192	-0.0255	0.0022	-0.0025	0.0202	-0.1466	-0.0173	-0.0365	0.0139
PC	0.0237	0.0078	-0.0203	-0.0220	-0.0106	0.0108	-0.0025	-0.0023	-0.0149	-0.0239	0.0214	0.0223	0.0086	0.0143	0.1207	0.0205	0.0557
GC	-0.0014	0.0027	0.0046	0.0043	-0.0047	-0.0049	0.0008	0.0021	-0.0006	-0.0002	0.0076	-0.0051	-0.0051	0.0056	0.0038	0.0225	0.0129

Residual effect = 0.6892

PH30: Plant height at 30 days PHH: Plant height at harvest DFF: Days to first flowering D50F: Days to 50% flowering PT: Pod thickness (mm) PL: Pod length (cm) PW: Pod width (mm) NPP: Number of pods per plant NPC: Number of pods per cluster NCP: Number of clusters per plant NBPM: Number of branches per plant at maturity NSP: Number of seeds per pod 100SW: 100 Seed weight DPM: Days to pod maturity PC: Protein content (%) GC: Gum content (%) PYPP: Pod yield per plant (g)

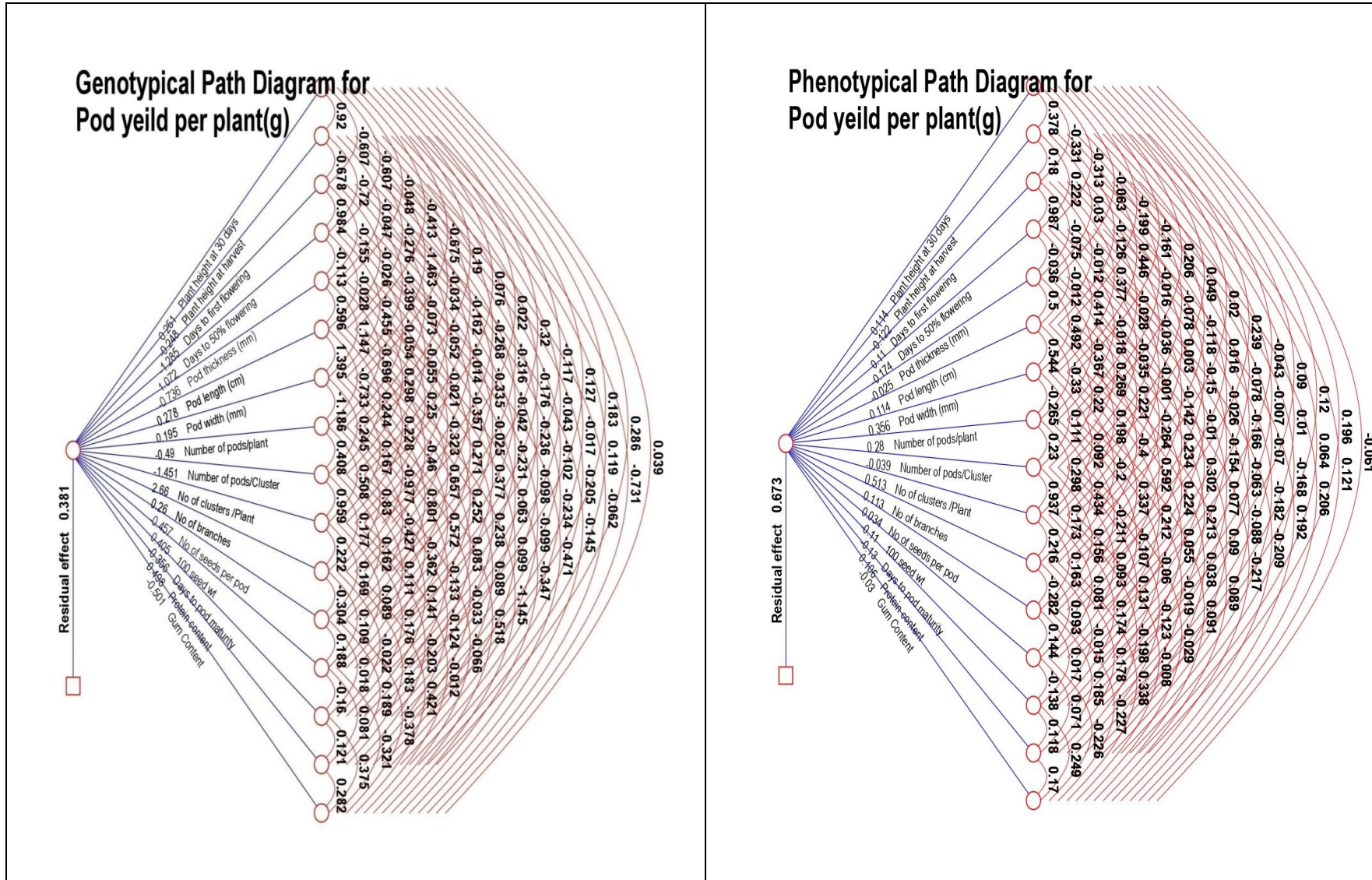
Table.5 Genotypic path coefficient analysis for different characters among forty five cluster bean genotypes

	PH30D	PHH	DFF	D50F	PT	PL	PW	NPP	NPC	NCP	NBPM	NSP	100SW	DPM	PC	GC	PYPP
PH30D	0.0482	0.0444	-0.0293	-0.0292	-0.0023	-0.0199	0.0167	0.0092	0.0037	0.0011	0.0154	-0.0057	0.0061	0.0088	0.0138	0.0019	-0.0614
PHH	0.0290	0.0315	-0.0213	-0.0227	-0.0015	-0.0087	0.0068	-0.0011	-0.0051	-0.0084	-0.0100	-0.0055	-0.0014	-0.0005	0.0038	-0.0230	-0.2587
DFF	1.0172	1.1360	-1.6767	-1.6494	0.2594	0.0430	0.6112	0.1232	0.0873	0.0233	0.5620	0.0708	0.3956	0.1705	0.3440	0.1038	-0.1186
D50F	-0.9041	-1.0732	1.4664	-1.4907	-0.1683	-0.0424	-0.4934	-0.0798	-0.0822	-0.0313	-0.5326	-0.0378	-0.3436	-0.1464	-0.3487	-0.2156	-0.1261
PT	0.0215	0.0207	0.0689	0.0503	-0.4451	-0.2655	-0.0809	0.3096	-0.1324	-0.1113	0.1435	-0.1206	-0.1678	-0.0280	0.0439	0.2096	0.1096
PL	-0.2298	-0.1533	-0.0143	-0.0158	0.3315	0.5559	-0.0304	-0.4074	0.1357	0.1266	-0.2559	0.3650	0.1403	0.1325	0.0550	-0.1929	0.3054
PW	-0.0756	-0.0474	0.0796	0.0723	-0.0397	0.0120	-0.2183	-0.0643	-0.0631	-0.0280	-0.0537	0.0031	0.1259	0.0346	0.0116	0.0298	0.2204
NPP	-0.0883	0.0157	0.0341	0.0248	0.3226	0.3399	-0.1366	0.4637	-0.1893	0.2356	-0.3847	0.1982	0.1679	0.0618	0.0154	-0.2400	0.7680
NPC	-0.0678	0.1445	0.0465	0.0492	-0.2654	-0.2178	-0.2580	-0.3641	-0.8921	0.8553	-0.1583	-0.1446	-0.0992	-0.1257	0.1108	0.0592	0.7115
NCP	0.0448	-0.5482	-0.0285	-0.0430	0.5122	0.4663	0.2626	1.0404	1.9636	2.0482	0.4552	0.3452	0.1816	0.3612	-0.4149	-0.0240	0.7865
NBPM	0.1656	-0.1637	-0.1735	-0.1849	-0.1669	-0.2383	0.1274	0.4293	0.0918	0.1150	0.5175	-0.1572	0.0562	-0.0111	0.0945	0.2177	0.2953
NSP	0.0361	0.0541	0.0130	0.0078	-0.0833	-0.2019	0.0044	0.1314	-0.0499	-0.0518	0.0934	-0.3075	-0.0578	-0.0055	-0.0582	0.1163	0.2687
100SW	-0.0696	0.0238	0.1294	0.1265	-0.2068	-0.1384	0.3164	0.1986	-0.0610	-0.0486	-0.0595	-0.1032	-0.5485	0.0876	-0.0445	0.1762	0.0507
DPM	-0.0865	0.0082	0.0481	0.0464	-0.0298	-0.1126	0.0748	0.0630	-0.0666	-0.0833	0.0102	-0.0085	0.0755	-0.4726	-0.0574	-0.1772	0.0092
PC	0.1089	0.0454	-0.0782	-0.0891	-0.0376	0.0377	-0.0202	-0.0126	-0.0473	-0.0772	0.0695	0.0721	0.0309	0.0462	0.3809	0.1075	0.0717
GC	-0.0109	0.2027	0.0172	0.0401	0.1306	0.0962	0.0379	-0.1435	0.0184	0.0032	-0.1167	0.1049	0.0891	-0.1040	-0.0783	-0.2773	-0.1278

Residual effect = 0.4545

PH30: Plant height at 30 days PHH: Plant height at harvest DFF: Days to first flowering D50F: Days to 50% flowering PT: Pod thickness (mm) PL: Pod length (cm) PW: Pod width (mm) NPP: Number of pods per plant NPC: Number of pods per cluster NCP: Number of clusters per plant NBPM: Number of branches per plant at maturity NSP: Number of seeds per pod 100SW: 100 Seed weight DPM: Days to pod maturity PC: Protein content (%) GC: Gum content (%) PYPP: Pod yield per plant (g)

Fig.1 Genotypic and phenotypic path diagram representing direct and indirect effects for pod yield per plant of forty five cluster bean genotypes



Path analysis was carried out at phenotypic and genotypic level considering pod yield per plant as dependent variable and its attributes as independent variables. Upon the assessment of apparent relationship between yield and yield components, it was necessary to partition the direct and indirect effects of each character on yield to understand the nature of association at genotypic and phenotypic level. The direct and indirect effects of different characters on yield per plant are presented in the Table 4 and 5.

From path analysis, it can be inferred that pod length, number of clusters per plant, number of pods per plant and number of clusters per plant exerted a high positive direct effect on pod yield per plant at both genotypic and phenotypic levels. The high direct effect of these traits appeared to be the main factor for their strong association with pod yield per plant. Hence, direct selection for these traits would be highly effective in improving the per plant pod yield. These results are in agreement with Kumar (2016) and Lekshmanan and Abdul (2016).

Pod length exhibited a very high positive indirect effect through number of pods per plant and number of seeds per pod on pod yield per plant. As pod length influences pod yield per plant through these characters, indirect selection for pod length via the aforesaid characters may be useful in improving the yield. Genotypic residual effect was found to be enough which indicates that selected traits for genotypes cover the maximum of genetic variation.

Number of clusters per plant exerted a positive indirect effect through number of pods per plant, number of pods per cluster, number of branches per plant at maturity and number of seeds per pod. Therefore, it would be rewarding to stress on number of pods per plant, number of pods per cluster and number

of branches per plant at maturity while making selection. Since this trait also showed high correlation and high direct effect on pod yield per plant, one can improve the pod yield per plant by making selection for these characters during yield improvement programme.

The results of the study indicated that the characters with positive correlation have shown high direct effects. Thus, pod length, number of clusters per plant, number of pods per plant, number of branches per plant at maturity and protein content had high direct and correlation values.

In conclusion, the correlation studies, revealed that fresh pod yield per plant had highly significant and positive association with pod length, number of pods per plant, number of pods per cluster, number of clusters per plant and number of branches per plant at maturity. Direct selection based on these traits could result in simultaneous improvement of afore said traits and marketable pod yield in cluster bean.

From path analysis, it can be inferred that very high positive direct effect on fresh pod yield per plant was exerted by number of clusters per pod at genotypic levels while pod length, number of clusters per plant, number of pods per plant and number of clusters per plant exerted a positive and high direct effect on fresh pod yield per plant at both genotypic and phenotypic levels.

High negative direct effect on fresh pod yield per plant was exerted by days to first flowering and days to 50 % flowering. High direct effect of these traits appeared to be the main factor for their strong association with pod yield per plant. Hence direct selection for these traits would be highly effective in improving the pod yield per plant.

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