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Correlation and path coefficient analysis in dolichos bean (*Dolichos lablab* L. var. *Typicus* Prain) genotypes

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Abstract
The present investigation was conducted at Vegetable Research Station, ARI, Rajendranagar, Hyderabad during August, 2016 to March, 2017. Thirty five genotypes were evaluated in Randomized Block Design with two replications evaluated for nineteen yield and yield contributing characters, which are diverse in origin. Correlation coefficient analysis revealed that Pod yield per plant exhibited positive significant correlation with vine length (0.511), number of pods per plant (0.494), pod weight (0.485), seed breadth (0.389), seed length (0.349), 100 dry seed weight (0.325), primary branches per plant (0.291), days to 50 percent flowering (0.254), days to first flowering (0.244) and pod length (0.240). Path analysis revealed that maximum positive direct effect on pod yield per plant was exhibited through pod weight (0.440) followed by protein content (0.235). Positive direct effect of primary branches per plant (0.229) on pod yield per plant was moderate. The direct negative effects on pod yield were observed by days to first flowering, days to last pod harvest and 100 dry seed weight.

Keywords: genotypes, dolichos bean, *Dolichos lablab* L., Correlation

Introduction
Dolichos bean commonly called as Indian bean, Hyacinth bean (*Dolichos lablab* L. var. *typicus* Prain) is an important leguminous vegetable crop widely grown in south and eastern India. Its green pods are used as vegetables and dry seeds as pulse. The pods are naturally rich in carbohydrates, proteins, fat and fibers, as well as minerals which include Ca, P and Fe (Naeem *et al.* 2009) [7]. It is one of the major sources of protein in the dietary of working class especially of the southern part of India (Murphy 1998) [6]. Though this crop originated in India, very little work has been done to study the varietal characters and to improve the quality of pod yield of the local strain available.
Yield being a complex trait, is collectively influenced by various yield attributes, which are polygenically inherited and influenced by environmental variations. The effective selection for improvement of these traits is determined by magnitude and nature of interaction between phenotypic and genotypic variability. Improvement made in crop varieties is mainly concentrated on increasing yield and yield attributing characters. Studies of correlation between different quantitative characters provide an idea of their association. It could be effectively exploited to formulate selection strategies for improving yield and quality. Correlation study does not reveal the direct and indirect contributions of individual character towards yield. Path coefficient analysis is used for estimating direct and indirect contribution of various components in building up the correlation towards yield. On the basis of these studies, the quantum importance of individual characters is marked to facilitate the selection programme in dolichos bean. Therefore, the present studies were aimed at to study the correlation and path analysis among thirty five genotypes of dolichos bean.

Materials and Methods
The experiment was conducted at Vegetable Research Station, ARI, Rajendranagar, Hyderabad during August, 2016 to March, 2017. Thirty five genotypes were evaluated in Randomized Block Design with two replications. Ten plants of each genotype grown with spacing of 5.0 m X 0.5 m. All recommended package of practices and plant protection measures were followed to ensure a normal healthy crop. For this study of correlation and path coefficient analysis, we used nineteen yield and yield contributing characters *viz.*,vine length (cm), number of primary branches per plant, days to first flowering, days to 50% flowering, days to first pod harvest, days to last pod harvest, days to pod maturity, pod length (cm), pod width (cm), pod weight (g), number of pods per plant, number of seeds per pod, seed length (mm), seed breadth (mm), 100 fresh seed weight (g), 100 dry seed weight (g), protein

content (%), fiber content (%) and pod yield per plant (g). Observations were recorded on five randomly selected competitive plants from each plot to record observations on nineteen yield and yield contributing components. The correlation coefficient analysis was carried out as per Al-jibouri *et al.* (1958) [1] and path coefficient of various characters was calculated by Dewey and Lu (1959) [4].

Results and Discussion

Correlation coefficient analysis: Phenotypic (P) and genotypic (G) correlation coefficients (table 1a and 1b) among nineteen yield and yield attributes in thirty-five genotypes of dolichos bean revealed that genotypic correlations were higher than respective phenotypic correlations indicating strong inherent relationship among the characters studied. The character Pod yield per plant exhibited positive significant correlation with vine length (0.511), number of pods per plant (0.494), pod weight (0.485), seed breadth (0.389), seed length (0.349), 100 dry seed weight (0.325), primary branches per plant (0.291), days to 50 percent flowering (0.254), days to first flowering (0.244) and pod length (0.240). These finding results are in coincidence with Bendale *et al*. (2008) [2], Chaitanya *et al*. (2014) [3] and Singh *et al*. (2015) [8]. Among the qualitative characters fiber content (-0.213) had negative significant association with the marketable pod yield per plant. Thus, the vine length and number of pods per plant seems to have predominated effect on pod yield per plant. Hence, there is ample scope in the improvement of yield by selecting a genotypes having vine length, number of pods per plant and pod weight they are highly correlated. On the contrary, among the qualitative characters fiber content (-0.213) had negative significant association with the marketable pod yield per plant.

The genotypic correlation of vine length and pod weight with yield was high and significant, which is the valuable index for effective selection towards higher yield. The phenotypic and genotypic correlations between the vine length, pod weight, number of pods per plant, seed length, seed breadth and 100 dry seed weight with yield were highly significant which means that yield is largely a function of these characters.

Path coefficient analysis

Path analysis (table 2a and 2b) revealed that maximum positive direct effect on pod yield per plant was exhibited through pod weight (0.440) followed by protein content (0.235). Positive direct effect of primary branches per plant (0.229) on pod yield per plant was moderate. The direct negative effects on pod yield were observed by days to first flowering, days to last pod harvest and 100 dry seed weight. Among all the pod traits under study, pod weight (0.440) exhibited high positive direct effect on pod yield per plant at phenotypic level and days to 50 percent flowering (3.680) exhibited high positive direct effect at genotypic level. Among all attributes, days to 50 percent flowering days to pod maturity, number of primary branches per plant and vine length showed moderate positive direct effect on pod yield per plant. The characters like seed length (0.502), 100 fresh seed weight (0.529) and number of seeds per pod (0.372) recorded significant positive correlation at genotypic level on pod yield per plant. This suggested that direct selection based on these traits will be rewarding for improvement in dolichos bean.

Days to last pod harvest (-2.109) showed very high negative direct effect on pod yield followed by 100 dry seed weight (-1.122). Fiber content exhibited low negligible direct effects on pod yield per plant. Similar findings are recorded by Magalingam *et al.* (2013) [5]. However, Rest of the characters showed negligible positive and negative direct effects.

From the foregoing discussion, it can be concluded that pod weight, seed length, number of primary branches per plant, 100 fresh seed weight, days to pod maturity, days to 50 percent flowering and vine length showed the positive correlation and positive direct effect on pod yield per plant. Hence, these are identified as superior components of yield. So, the genotypes which exhibited better performance for these characters can be used in further improvement of dolichos bean.

The residual effect in the present study was high in genotypic (0.47) and phenotypic (0.427) path-coefficient analysis, indicating that there is need to include other characters in order to derive a much clear picture of the casual relationship.

Conclusion

It is concluded from the study that existence of correlation among yield and yield contributing characters. The characters like vine length, days to first flowering, days to first pod harvest, number of pods per plant, pod weight, pod length, pod width, protein content and pod yield per plant can further be improved through selection. A large number of pests and diseases affect the crop. There is a need to systematically test the genotypes for pest and disease reaction. They can be directly selected for general cultivation after confirming their performance in large plots across environments.

Table 1 (a): Phenotypic (P) correlation coefficients among nineteen yield and yield attributes in thirty five genotypes of dolichos bean

	Vine length (cm)	Primary branches per plant	Days to first flowering	Days to 50%flowering	Days to first pod harvest	Days to last pod harvest	Days to pod maturity	Pod length (cm)	Pod width (cm)	Pod weight (g)	Number of pods per plant	Number of seeds per pod	Seed length (mm)	Seed breadth (mm)	100 fresh seed weight (g)	100 dry seed weight (g)	Protein content (%)	Fiber content (%)	Correlation coefficient
VL	1.000	0.081	0.662**	0.569**	0.634**	0.165	0.131	0.326**	0.202	0.471**	0.212	0.294*	0.313**	0.155	0.367**	0.401**	-0.148	0.157	0.511**
PBPP	0.081	1.000	-0.166	-0.214	-0.239*	-0.161	-0.048	0.118	0.239*	0.130	0.004	0.185	0.105	0.101	-0.098	0.190	-0.065	-0.252*	0.291*
DFF	0.662**	-0.166	1.000	0.938**	0.905**	0.418**	0.361**	0.039	0.049	0.279*	0.160	0.170	-0.00	-0.023	0.230	0.295*	-0.158	0.239*	0.244*
D 50%F	0.569**	-0.214	0.938**	1.000	0.926**	0.516**	0.43**	-0.047	0.004	0.281*	0.211	0.206	-0.028	-0.033	0.218	0.348**	-0.151	0.282*	0.254*
DFPH	0.634**	-0.239*	0.905**	0.926**	1.000	0.513**	0.425**	0.061	-0.035	0.240*	0.193	0.214	-0.004	-0.080	0.294*	0.279*	-0.140	0.199	0.226
DLPH	0.165	-0.161	0.418**	0.516**	0.513**	1.000	0.923**	-0.243*	-0.134	0.114	0.178	0.085	-0.171	-0.096	0.161	0.192	0.151	0.103	0.159
DPM	0.131	-0.048	0.361**	0.437**	0.425**	0.923**	1.000	-0.243*	-0.134	0.114	-0.003	0.074	-0.169	-0.051	0.200	0.236*	0.240*	0.155	0.139
PL	0.326**	0.118	0.039	-0.047	0.061	-0.243*	-0.187	1.000	0.270*	0.394**	-0.248*	0.135	0.492**	0.344**	0.472**	-0.015	0.131	-0.234*	0.240*
PW	0.202	0.239*	0.049	0.004	-0.035	-0.134	-0.124	0.27*	1.000	0.361**	-0.146	-0.055	0.497**	0.491**	0.128	0.183	-0.122	-0.198	0.160
PWT	0.471**	0.130	0.279*	0.281*	0.240*	0.114	0.165	0.394**	0.361**	1.000	-0.244*	0.297*	0.390**	0.562**	0.461**	0.469**	-0.008	0.065	0.485**
NPP	0.212	-0.004	0.160	0.211	0.193	0.178	-0.003	-0.248*	-0.146	-0.244*	1.000	0.034	-0.135	-0.141	-0.194	-0.003	-0.219	-0.265*	0.495**
NSP	0.294*	0.185	0.170	0.206	0.214	0.085	0.074	0.135	-0.055	0.297*	0.034	1.000	0.046	-0.002	0.340**	0.376**	-0.106	-0.197	0.143
SL	0.313**	0.105	-0.006	-0.028	-0.004	-0.171	-0.169	0.492**	0.497**	0.390**	-0.135	0.046	1.000	0.553**	0.381**	0.173	0.092	-0.206	0.349**
SB	0.155	0.101	-0.023	-0.033	-0.080	-0.096	-0.051	0.344**	0.491**	0.562**	-0.141	-0.002	0.553**	1.000	0.240*	0.158	-0.037	-0.171	0.389**
100FSW	0.367**	-0.098	0.230	0.218	0.294*	0.161	0.200	0.472**	0.128	0.461**	-0.194	0.340**	0.381**	0.240*	1.000	0.247*	0.101	0.036	0.220
100DSW	0.401**	0.190	0.295*	0.348**	0.272*	0.192	0.236*	-0.015	0.183	0.469**	-0.003	0.376**	0.173	0.158	0.247*	1.000	-0.165	0.095	0.325**
PC	-0.148	-0.065	-0.158	-0.151	-0.140	0.151	0.240*	0.131	-0.122	-0.008	-0.219	-0.106	0.092	-0.037	0.101	-0.165	1.000	0.075	0.086
FC	0.057	-0.252*	0.239*	0.282*	0.199	0.103	0.155	-0.234	-0.198	0.065	-0.265*	0.197	-0.206	-0.171	0.036	0.095	0.075	1.000	-0.213
MPYP	0.511**	0.291*	0.244*	0.254*	0.226	0.159	0.139	0.240*	0.160	0.485**	0.494**	0.143	0.349**	0.389**	0.220	0.325**	0.086	-0.213	1.000

*significant at 5% LOS ** significant at 1 % LOS

VL=vine length(cm);PBPP= Primary branches per plant ; DFF= Days to first flowering ;DFPF = Days to 50 *per cent* flowering ;DFPH= Days to first pod harvest; DLPH= Days to last pod harvest ; DPM=Days to pod maturity ; PL= Pod length (cm) ; PW=Pod width (cm) ; PWT= Pod weight (g) ; NPP= Number of pods per plant; NSP=Number of seeds per pod ; SL=Seed length (mm); SB=seed breadth (mm); 100FSW= 100 fresh seed weight; 100 DSW= 100 dry seed weight; PC= Protein content (%) ; FC=Fiber content (%); MPYP=Marketable pod yield per plant.

Table 1 (b): Genotypic (G) correlation coefficients among nineteen yield and yield attributes in thirty five genotypes of dolichos bean

	Vine length (cm)	Primary branches per plant	Days to first flowering	Days to 50%flowering	Days to first pod harvest	Days to last pod harvest	Days to pod maturity	Pod length (cm)	Pod width (cm)	Pod weight (g)	Number of pods per plant	Number of seeds per pod	Seed length (mm)	Seed breadth (mm)	100 fresh seed weight(g)	100 dry seed weight (g)	Protein content (%)	Fiber content (%)	Correlation coefficient
VL	1.000	0.070	0.779**	0.672**	0.692**	0.158	0.105	0.348**	0.282*	0.567**	0.217	0.333**	0.384**	0.300**	0.412**	0.576**	-0.155	0.062	0.540**
PBPP	0.070	1.000	-0.073	-0.112	-0.220*	-0.122	-0.016	0.061	0.359**	0.223	0.019	0.200	0.184	0.180	-0.203	0.413**	-0.060	-0.326**	0.427**
DFF	0.779**	-0.073	1.000	0.968**	0.958**	0.368**	0.351**	0.060	0.040	0.332**	0.164	0.323**	0.024	-0.011	0.279*	0.468**	-0.247	0.272*	0.251*
D 50%F	0.672**	-0.112	0.968**	1.000	0.966**	0.455**	0.449**	-0.035	-0.017	0.302**	0.232	0.305**	-0.014	-0.003	0.276*	0.500**	-0.239*	0.324**	0.271*
DFPH	0.692**	-0.220	0.958**	0.966**	1.000	0.423**	0.376**	0.055	-0.033	0.292*	0.211	0.333**	0.029	-0.053	0.365**	0.417**	-0.250*	0.207	0.24*
DLPH	0.158	-0.122	0.368**	0.455**	0.423**	1.000	0.963**	-0.31**	-0.186	0.143	0.198	0.096	-0.185	-0.055	0.160	0.260*	0.139	0.112	0.174

DPM	0.105	-0.016	0.351**	0.449**	0.376**	0.963**	1.000	-0.253*	-0.177	0.253**	0.000	-0.003	-0.193	-0.018	0.172	0.288*	0.234	0.164	0.172
PL	0.348**	0.061	0.060	-0.035	0.055	-0.314**	-0.253*	1.000	0.361**	0.480**	-0.241*	0.132	0.590**	0.463**	0.557**	-0.013	0.144	-0.270*	0.279*
PW	0.282*	0.359**	0.040	-0.017	-0.033	-0.186	-0.177	0.361**	1.000	0.430**	-0.207	-0.319**	0.669**	0.718**	0.241*	0.240*	-0.171	-0.185	0.178
PWT	0.567**	0.223	0.332**	0.302*	0.292*	0.143	0.253*	0.480*	0.430*	1.000	-0.272*	0.409**	0.384**	0.734**	0.613**	0.621**	0.021	0.071	0.534**
NPP	0.217	0.019	0.164	0.232	0.211	0.198	0.000	-0.241*	-0.207	-0.272*	1.000	0.030	-0.142	-0.169	-0.219	-0.030	-0.233	-0.265*	0.478**
NSP	0.133	0.200	0.323**	0.305**	0.333**	0.096	-0.003	0.132	-0.31**	0.409**	0.030	1.000	-0.077	0.018	0.447**	0.550**	-0.181	-0.275*	0.217
SL	0.384**	0.184	0.024	-0.014	0.029	-0.185	-0.193	0.590**	0.669**	0.384**	-0.142	-0.077	1.000	0.778**	0.419**	0.113	0.137	-0.238**	0.415**
SB	0.300*	0.180	-0.011	-0.003	-0.053	-0.055	-0.018	0.463**	0.718**	0.734**	-0.169	0.018	0.778**	1.000	0.469**	0.276*	0.020	-0.209	0.539**
100FSW	0.412**	-0.203	0.279*	0.276*	0.365**	0.160	0.172	0.557**	0.241*	0.613**	-0.219	0.447**	0.419**	0.469**	1.000	0.446**	0.111	0.077	0.283*
100DSW	0.576**	0.413**	0.468**	0.500**	0.417**	0.260*	0.288*	-0.013	0.240*	0.621**	-0.030	0.500**	0.113	0.276*	0.446**	1.000	-0.254*	0.118	0.472**
PC	-0.155	-0.060	-0.247*	-0.239*	-0.205	0.139	0.234	0.144	-0.171	0.021	-0.233	-0.181	0.137	0.020	0.111	-0.254*	1.000	0.072	0.107
FC	0.062	-0.326**	0.272*	0.324**	0.207	0.112	0.164	-0.270*	-0.185	0.071	-0.265*	-0.275*	-0.238*	-0.209	0.077	0.118	0.072	1.000	-0.218
MPYP	0.540**	0.427**	0.251*	0.271*	0.242*	0.174	0.172	0.279*	0.178	0.534**	0.478**	0.217	0.415**	0.539**	0.283*	0.472**	0.107	-0.218	1.000

*significant at 5% LOS ** significant at 1 % LOS

VL=vine length(cm);PBPP= Primary branches per plant ; DFF= Days to first flowering; DFPF = Days to 50 *per cent* flowering ;DFPH= Days to first pod harvest; DLPH= Days to last pod harvest ; DPM=Days to pod maturity ; PL= Pod length (cm) ; PW=Pod width (cm) ; PWT= Pod weight (g) ; NPP= Number of pods per plant; NSP=Number of seeds per pod ; SL=Seed length(mm); SB=seed breadth (mm); 100FSW= 100 fresh seed weight; 100 DSW= 100 dry seed weight; PC= Protein content (%) ; FC=Fiber content(%); MPYP=Marketable pod yield per plant.

Table 2 (a): Phenotypic direct and indirect effects of 18 characters on pod yield in thirty five genotypes of dolichos bean.

	Vine length (cm)	**Primary branches per plant**	**Days to first flowering**	**Days to 50%flowering**	**Days to first pod harvest**	**Days to last pod harvest**	**Days to pod maturity**	**Pod length (cm)**	**Pod width (cm)**	**Pod weight (g)**	**No.of pods per plant**	**No.of seeds per pod**	**Seed length (mm)**	**Seed breadth (mm)**	**100 fresh seed weight(g)**	**100 dry seed weight (g)**	**Protein content (%)**	**Fiber content (%)**	**Correlation coefficient**
VL	0.101	0.008	0.067	0.057	0.064	0.016	0.013	0.033	0.020	0.047	0.021	0.029	0.031	0.015	0.037	0.040	0.015	0.005	0.511
PBPP	0.01	0.229	-0.038	-0.049	-0.054	-0.037	-0.011	0.027	0.054	0.030	0.000	0.042	0.024	0.023	-0.022	0.043	-0.014	-0.057	0.291
DFF	-0.001	0.000	-0.001	-0.001	-0.001	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	0.000	0.000	-0.000	-0.000	0.000	-0.000	0.244
D FPF	0.036	-0.013	0.060	0.064	0.059	0.033	0.028	-0.003	0.000	0.018	0.013	0.013	-0.001	-0.002	0.01	0.022	-0.009	0.018	0.254
DFPH	0.006	0.002	-0.009	-0.009	-0.010	-0.005	-0.004	-0.000	0.000	-0.002	0.002	-0.002	0.000	0.000	-0.003	-0.002	0.001	-0.002	0.226
DLPH	0.035	0.034	-0.088	-0.109	-0.109	-0.212	-0.195	0.051	0.028	-0.024	0.037	-0.018	0.036	0.020	-0.034	-0.040	-0.032	-0.022	0.159
DPM	0.025	-0.009	0.070	0.085	0.083	0.181	0.096	-0.036	-0.024	0.032	-0.000	0.014	-0.033	-0.010	0.039	0.046	0.047	0.030	0.139
PL	0.017	0.00	0.002	-0.002	0.003	-0.013	-0.010	0.053	0.014	0.021	-0.013	0.007	0.026	0.018	0.025	-0.000	0.007	-0.012	0.240
PW	-0.026	-0.031	-0.006	-0.000	0.004	0.017	0.016	-0.035	-0.131	-0.047	0.019	0.007	-0.065	-0.064	-0.017	-0.024	0.016	0.026	0.160
PWT	0.207	0.057	0.123	0.124	0.105	0.050	0.072	0.173	0.159	0.440	-0.107	0.130	0.172	0.247	0.203	0.206	-0.003	0.028	0.485
NPP	0.146	-0.002	0.110	0.146	0.133	0.123	-0.002	-0.171	-0.101	-0.169	-0.691	0.023	-0.093	-0.097	-0.134	-0.002	-0.151	-0.183	0.494
NSP	0.040	-0.025	-0.023	-0.028	-0.029	-0.011	-0.010	-0.018	0.007	-0.040	-0.004	-0.137	-0.006	0.000	-0.046	-0.051	0.014	0.027	0.143
SL	0.036	0.012	-0.000	-0.003	-0.000	-0.019	-0.019	0.056	0.057	0.045	-0.015	0.005	0.115	0.064	0.044	0.020	0.010	-0.023	0.349
SB	0.023	0.015	-0.003	-0.005	-0.012	-0.014	-0.007	0.052	0.075	0.086	-0.021	-0.000	0.084	0.152	0.036	0.024	-0.005	-0.026	0.389
100FSW	0.003	-0.003	0.008	0.008	0.010	0.005	0.007	0.017	0.004	0.017	-0.007	0.012	0.014	0.008	0.036	0.009	0.003	0.001	0.220
100DSW	0.031	0.0152	0.023	0.027	0.021	0.015	0.018	-0.001	0.041	0.037	-0.000	0.029	0.013	0.012	0.019	0.079	-0.013	0.007	0.325
PC	-0.035	-0.015	-0.037	-0.035	-0.033	0.035	0.056	0.030	-0.028	-0.002	-0.051	-0.025	0.021	-0.008	0.023	-0.039	0.235	0.017	0.086
FC	-0.002	0.012	-0.011	-0.013	-0.009	-0.005	-0.007	0.01	0.009	-0.003	0.012	0.009	0.009	0.008	-0.001	-0.004	-0.003	-0.047	-0.213

Phenotypic Residual effect=0.43; Diagonal (under lined) values indicate direct effects

VL=vine length(cm);PBPP= Primary branches per plant ; DFF= Days to first flowering ;DFPF = Days to 50 *per cent* flowering ;DFPH= Days to first pod harvest; DLPH= Days to last pod harvest ; DPM=Days to pod maturity ; PL= Pod length (cm) ; PW=Pod width (cm) ; PWT= Pod weight (g) ; NPP= Number of pods per plant; NSP=Number of seeds per pod ; SL=Seed length(mm); SB=seed breadth (mm); 100FSW= 100 fresh seed weight; 100 DSW= 100 dry seed weight; PC= Protein content (%) ; FC=Fiber content(%).

Table 2 (b): Genotypic direct and indirect effects of 18 characters on pod yield in thirty five genotypes of dolichos bean.

	Vine length (cm)	Primary branches per plant	Days to first flowering	Days to 50%flowering	Days to first pod harvest	Days to last pod harvest	Days to pod maturity	Pod length (cm)	Pod width (cm)	Pod weight (g)	No. of pods per plant	No. of seeds per pod	Seed length (mm)	Seed breadth (mm)	100 fresh seed weight (g)	100 dry seed weight (g)	Protein content (%)	Fiber content (%)	Correlation coefficient
VL	1.695	0.119	1.321	1.140	1.173	0.268	0.178	0.590	0.479	0.962	0.368	0.565	0.651	0.509	0.699	0.977	-0.263	0.105	0.540
PBPP	0.014	0.205	-0.015	-0.023	-0.045	-0.025	-0.003	0.012	0.073	0.045	0.004	0.041	0.037	0.037	-0.041	0.085	-0.012	-0.067	0.427
DFF	-2.755	0.260	-3.537	-3.424	-3.389	-1.302	-1.243	-0.212	-0.142	-1.074	-0.580	-1.144	-0.086	0.041	-0.986	-1.658	0.876	-0.962	0.251
DFPF	2.475	-0.413	3.563	3.680	3.558	1.677	1.655	-0.131	-0.065	1.112	0.854	1.123	-0.053	-0.011	1.016	1.824	-0.882	1.193	0.271
DFPH	-0.760	0.242	-1.053	-1.062	-1.099	-0.465	-0.414	-0.060	0.036	-0.321	0.232	-0.366	-0.032	0.059	-0.401	-0.459	0.225	-0.228	0.242
DLPH	0.333	0.257	-0.776	-0.961	-0.894	-2.109	-2.033	0.661	0.392	-0.303	0.419	-0.204	0.391	0.117	-0.339	-0.550	-0.294	-0.236	0.174
DPM	0.222	-0.038	0.741	0.948	0.794	2.033	2.109	-0.696	-0.251	-0.534	0.001	-0.006	-0.408	-0.039	0.364	0.609	0.495	0.346	0.172
PL	-0.242	-0.042	-0.041	0.024	-0.038	0.218	0.176	-0.696	-0.251	-0.334	0.168	-0.092	-0.411	-0.322	-0.387	0.009	-0.100	0.188	0.279
PW	0.103	0.130	0.014	-0.006	-0.012	-0.067	-0.064	0.131	0.364	0.156	-0.07	-0.116	0.243	0.261	0.088	0.087	-0.062	-0.067	0.178
PWT	0.434	0.171	0.254	0.231	0.223	0.110	0.194	0.367	0.329	0.765	-0.208	0.313	0.294	0.562	0.469	0.475	0.016	0.055	0.534
NPP	0.102	0.009	0.077	0.109	0.099	0.093	0.000	-0.113	-0.097	-0.128	0.171	0.014	-0.067	-0.079	-0.103	-0.014	-0.109	-0.125	0.478
NSP	0.124	0.074	0.120	0.113	0.124	0.036	-0.001	0.049	-0.118	0.152	0.011	0.372	-0.029	0.006	0.166	0.186	-0.067	-0.102	0.217
SL	0.193	0.092	0.012	-0.007	0.014	-0.093	-0.097	0.296	0.336	0.193	-0.071	-0.039	0.502	0.391	0.210	0.056	0.069	-0.119	0.415
SB	-0.298	-0.179	0.011	0.003	0.053	0.055	0.018	-0.461	-0.714	-0.730	0.168	-0.018	-0.773	-0.994	-0.466	-0.275	-0.020	0.208	0.539
100FSW	0.218	-0.107	0.147	0.146	0.193	0.085	0.091	0.295	0.128	0.325	-0.116	0.236	0.222	0.248	0.529	0.236	0.058	0.040	0.283
100DSW	-0.647	-0.464	-0.526	-0.561	-0.468	-0.292	-0.324	0.014	-0.269	-0.696	0.034	-0.561	-0.127	-0.310	-0.510	-1.122	0.285	-0.133	0.472
PC	0.013	0.005	0.020	0.020	0.017	-0.011	-0.019	-0.012	0.014	-0.001	0.019	0.015	-0.011	-0.001	-0.009	0.021	-0.084	-0.006	0.107
FC	-0.01	0.100	-0.083	-0.009	-0.063	-0.034	-0.050	0.083	0.056	-0.020	0.081	0.084	0.073	0.064	-0.023	-0.036	-0.022	-0.306	-0.218

Genotypical Residual effect=0.47; Diagonal (under lined) values indicate direct effects

VL=vine length(cm);PBPP= Primary branches per plant ; DFF= Days to first flowering; DFPF = Days to 50 *per cent* flowering ;DFPH= Days to first pod harvest; DLPH= Days to last pod harvest ; DPM=Days to pod maturity ; PL= Pod length (cm) ; PW=Pod width (cm) ; PWT= Pod weight (g) ; NPP= Number of pods per plant; NSP=Number of seeds per pod ; SL=Seed length (mm); SB=seed breadth (mm); 100FSW= 100 fresh seed weight; 100 DSW= 100 dry seed weight; PC= Protein content (%) ; FC=Fiber content(%).

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