www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2021; 10(11): 2818-2821
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www.thepharmajournal.com
Received: 06-09-2021
Accepted: 13-10-2021

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Correlation and path studies in F_1 and parental populations of rice bean (*Vigna umbellata* (Thunb.) Ohwi and Ohashi) for quantitative traits

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Abstract
The present investigation was carried out in *kharif* season during the year 2016-17 on 12 F_1 progenies and 8 parental genotypes of rice bean using randomized block design with three replication for 11 characters. The analysis of phenotypic and genotypic correlation coefficient for parents and progenies was carried out separately to study the pattern of character association and direct and indirect effects of various characters. The result on phenotypic and genotypic correlation coefficient revealed that for parents, seed yield per plant exhibited significant positive correlation with days to flowering, days to maturity, plant height, pods per plant, pods per clusters, 100-seed weight and pod length while for progeny seed yield per plant was significantly and positively correlated with plant height, branches per plant, pods per plant, clusters per plant and pods per cluster. Path coefficient analysis of different yield contributing traits revealed that for parents days to maturity, plant height, pods per plant, pods per cluster, 100-seed weight and pod length exhibited positive direct effects on seed yield while for progeny days to flowering, days to maturity, plant height, cluster per plant and pods per cluster exhibited positive direct effects.

Keywords: Rice bean *Vigna umbellata*, path coefficient, phenotypic correlation, yield components

Introduction

Vigna umbellata (Thunb.) Ohwi and Ohashi (2n=2x=22), previously *Phaseolus calcaratus*, is a warm season annual vine legume with yellow flowers and small edible beans. It is commonly called rice bean or rice bean. To date, it is little known, little researched and little exploited. It is regarded as a minor food and fodder crop and often grown as inter crop or mixed crop with maize, sorghum or cowpea as well as sole crop in uplands, on a very limited area. Like other Asiatic *Vigna* species, rice bean is fairly short lived warm season annual. Rice bean grows well on a range of soils. It establishes rapidly and potential to produce large amounts of nutritious animal fodder and high quality grains.

Seed yield is a complex trait conditioned by the interaction of various growth and physiological processes throughout the life cycle. The appropriate knowledge of such interrelationships between seed yield and its contributing components can significantly improve the efficiency of breeding programme through the use of appropriate selection indices. The nature of association between seed yield and its components determine the appropriate traits to be used in indirect selection for improvement in seed yield. Besides these, knowledge of the correlations among the traits is also of great importance to expect the success due to selections in subsequent generations for which analysis of correlation coefficient is the most widely used method. The correlation co-efficient gives, an idea of the nature and intensity of association between two or more quantitative characters between yield and yield contributing characters. Correlation simply measures that mutual relationship between yield and yield contributing characters. Thus, correlation helps in the selection of superior genotype from diverse genetic populations. As there are number of factors involved in correlation studies, their indirect associations become more complex and confusing but path analysis helps to avoid this complication by measuring the direct influence of one characters on other as well as permits the partitioning of given correlation coefficients into its components of direct and indirect effects. The path coefficient analysis is an effective means of analysing direct and causes of association and permits the critical examination of the specific that produce a given correlation. The path analysis provides information about magnitude and direction of direct and indirect effect of the yield components, which cannot provide by correlation.

Material and Methods

The present investigation on study of "Correlation and Path Coefficient Analysis between Seed Yield and Its Component in Rice Bean (*Vigna Umbellata* (Thunb.) Ohwi and Ohashi" was carried out in *kharif* season during the year 2016-17. The study was undertaken on 12 F_1 progenies and 8 parental genotypes of ricebean. These 20 genotypes (12 F_1's and 8 parents) were sown in *kharif* 2016 in randomized block design with three replications and each genotype was sown in 1 m long single row spaced 30 cm apart. Within rows seeds were sown at 10 cm distance. Observations were recorded on five randomly selected plants from each F_1 and parents on eleven quantitative traits *viz.,* days to 50% flowering, days to 75% maturity, plant height (cm), branches per plant, pods per plant, clusters per plant, pods per cluster, seeds per pod, 100-seed weight (g), pod length (cm) and yield per plant (g).Correlation and Path coefficient analysis was performed as suggested by (Dewey and Lu, 1959) [1].

Results and Discussion

Correlation studies

In order to find out the association between yield and yield contributing characters, the genotypic and phenotypic correlation coefficients were estimated and presented in Table 1 and 2.

In parents (Table 1), seed yield per plant exhibited significant positive correlation with days to flowering, days to maturity, plant height, pods per plant, pod per clusters, 100-seed weight and pod length. Days to flowering was significantly positively correlated with days to maturity, plant height, pods per plant, pod per cluster, 100-seed weight and pod length. Days to maturity was significantly positively correlated with plant height, pods per plant, 100-seed weight and pod length. Plant height shows significantly positive correlation with pods per plant, 100-seed weight and pod length. Pods per plant shows significant and positive correlation with clusters per plant, pods per cluster and pod length. Pods per cluster and100-seed weight were significantly and positively correlated with pod length.

In progeny (Table 2), seed yield per plant is significantly and positively correlated with plant height, branches per plant, pods per plant, clusters per plant and pods per cluster. Days to flowering was significantly positively correlated with days to maturity, pods per plant and clusters per plant. Days to maturity was significantly and positively correlated with branches per plant and pod length. Plant height was significantly and positively correlated with branches per plant, pods per plant, clusters per plant and pods per clusters.

Path Co-efficient analyses

Path coefficient analysis provides better means for selection by resolving the correlation coefficient of yield and its components into direct and indirect effects. The present investigation was therefore, aimed to estimate the direct and indirect effects of different characters on seed yield per plant. The values of path analysis at the phenotypic and genotypic levels are presented in Table 3 and 4.

In parents, seven traits *viz.,* days to flowering, days to maturity, plant height, pods per plant, pods per cluster, 100-seed weight and pod length showed significant positive correlation with seed yield per plant whereas in progeny five traits *viz.,* plant height, branches per plant, pods per plant, clusters per plant and pods per cluster showed significant positive correlation with seed yield per plant but when direct and indirect contributions of the correlation was estimated, the direct effect were found to be positive and highest for days to maturity followed by pods per plant and pod length in case of parents whereas for progeny the direct effect were found to be positive and highest for clusters per plant followed pods per cluster and days to maturity indicating that direct selection for these traits will be useful for selecting superior genotypes. In parents, days to flowering exhibit negative direct effect but showed significant positive correlation with seed yield via highest indirect effect of days to maturity followed by pod length whereas in progeny, its correlation with yield is non-significant. Days to maturity showed significant positive correlation with seed yield per plant via highest indirect effects of pod length followed by pods per plant while highest indirect effect on seed yield through plant height was exhibited by days to maturity in parents while in progeny, its correlation with yield is non-significant. Pod length showed significant positive correlation with seed yield via highest indirect effect of days to maturity in case of parents but same is found non-significant in case of progeny. Pods per plant showed significant positive correlation with seed yield per plant via highest indirect effects of days to maturity followed by pod length in case of parents while in case of progeny, it exhibited negative direct effect but showed significant positive correlation with seed yield via highest indirect of clusters per plant followed by plant height. Pods per cluster showed significant positive correlation with seed yield per plant via high indirect effect of days to maturity followed by pods per plant while on other hand, in progeny it is also significantly and positively correlated with seed yield via highest indirect effect of clusters per plant. In parents, 100-seed weight showed significant positive correlation with seed yield per plant via high indirect effect of days to maturity followed by pod length whereas in progeny, it is found non-significant. In parents, plant height showed significant positive correlation with seed yield per plant via highest indirect effect of days to maturity. Progeny also showed significant positive correlation of plant height with seed yield per plant via highest indirect effect of clusters per plant followed by pods per cluster in progeny. Branches per plant exhibited negative direct effect but showed significant positive correlation with seed yield via highest indirect effect of clusters per plant followed by pods per cluster while same is non-significant in parents. Clusters per plant showed significant positive correlation with seed yield per plant via highest indirect effect of plant height followed by pods per cluster in progeny while same is also found non-significant in parents. In parents, pods per cluster showed significant positive correlation with seed yield per plant via highest indirect effect of days to maturity followed by pods per plant while same is also found true in case of progeny except that highest indirect effect was found because of clusters per plant followed by plant height.

Similar results were obtained by various workers, Garje *et al.*, (2014) [2] observed that the seed yield per plant in green gram was significantly and positively correlated with number of primary and secondary branches per plant, cluster per plant, pod per plant and seed per pod. Path analysis revealed that number of pod per plant had maximum direct effect on seed yield followed by cluster per plant and secondary branches per plant. Srinivas *et al.*, (2016) [5] observed the path coefficient analysis of different yield and yield contributing traits on number of branches per plant, nodes per plant, cluster per plant, green pods per plant, pods per plant, seeds per pod,

pod weight (g), pod yield per plot and percentage of protein content in cowpea exhibited positive direct effects on pod yield per plot. Sohel *et al*., (2016) [4] observed that biomass per plant in black gram had maximum positive direct effects on yield per plant followed by pods per plant, seeds per pod by path coefficient analysis. Pandey *et al*. (2016) [3] recorded that days to 50% flowering has positive significant correlation with days to maturity, plant height and pods per plant. Pods per plant have positive significant correlation with plant height, secondary branches per plant and days to maturity. Plant height has positive significant correlation with days to maturity and secondary branches per plant. The path coefficient analysis revealed that days to 50% flowering, primary branches/plant, secondary branches/plant, 100 seed weight and no of seeds per pod had positive direct effect on seed yield, while plant height, days to maturity and pods per plant had negative direct effects on seed yield.

Table 1: Estimates of phenotypic and genotypic correlation coefficient among various traits in parents

Traits		Days to Maturity	Plant height	Branches per plant	Pods per plant	Clusters per plant	Pods per cluster	Seeds per pod	100-seed weight	Pod length	Yield per plant
Days to flowering	P	.9083*	.9321*	.0575	.7672*	.3140	.4778*	.2789	.6474*	.9066*	.8570*
	G	.9235	.9570	.0771	.8255	.3267	1.6716	.3261	.7763	.9558	.9656
Days to Maturity	P		.9409*	.0232	.5639*	.1826	.3164	.3566	.4628*	.8250*	.8106*
	G		.9953	.0274	.6556	.2042	1.3749	.4731	.5860	.9158	.9231
Plant height	P			-.0428	.6142*	.1689	.3741	.2610	.5309*	.8516*	.8432*
	G			.0346	.6858	.1658	1.4536	.2724	.6146	.9221	.9518
Branches per plant	P				.1787	.0700	.1368	.3440	-.0883	.2526	-.3105
	G				.1903	.1184	.3880	.4020	.0414	.2628	-.1927
Pods per plant	P					.5073*	.4914*	.1934	.3423	.6538*	.6725*
	G					.5559	1.3967	.1726	.5425	.6799	.7806
Clusters per plant	P						.2256	.1712	.0147	.1019	.2098
	G						.3832	.1523	-.0238	.1186	.2449
Pods per cluster	P							.1007	.3911	.4879*	.4222*
	G							.0036	1.3620	1.4871	1.6635
Seeds per pod	P								.2752	.4667*	.0598
	G								.3883	.4929	.1470
100-seed weight	P									.6483*	.5417*
	G									.9042	.6631
Pod length	P										.7033*
	G										.8401

**P*≤ 0.05 P=Phenotypic correlations G=Genotypic correlations

Table 2: Estimates of phenotypic and genotypic correlation coefficient among various traits in progeny

Traits		Days to Maturity	Plant height	Branches per plant	Pods per plant	Clusters per plant	Pods per cluster	Seeds per pod	100-seed weight	Pod length	Yield per plant
Days to flowering	P	.4350*	-.0916	.1768	.4624*	.3809*	-.3130	-.4756*	-.3521*	-.0608	.1362
	G	.4787	-.1096	.1972	.4819	.4155	-.3248	-.6032	-.4171	-.1057	.2786
Days to Maturity	P		.0974	.3802*	.2417	.1310	.0921	.0221	-.7074*	.4780*	.3167
	G		.0908	.3919	.2525	.1346	.1104	.0322	-.7663	.5399	.4018
Plant height	P			.5093*	.6202*	.5612*	.4488*	.2179	-.0194	.1508	.5606*
	G			.5809	.6434	.5798	.4903	.3347	-.0193	.2141	.6925
Branches per plant	P				.5879*	.6206*	.3803*	-.2975	-.1385	.0590	.5208*
	G				.6471	.6663	.4561	-.3081	-.1932	.0876	.6349
Pods per plant	P					.8187*	.3057	-.1450	-.1213	.1615	.5011*
	G					.8379	.3138	-.1467	-.1224	.1799	.6163
Clusters per plant	P						.2417	-.2641	.1625	-.0332	.6216*
	G						.2713	-.3003	.1654	-.0213	.7377
Pods per cluster	P							.1962	-.1341	.4597*	.4717*
	G							.2545	-.1423	.5613	.5115
Seeds per pod	P								.1522	.5265*	-.0871
	G								.1649	.5704	-.1272
100-seed weight	P									-.3641*	-.1178
	G									-.4466	-.1707
Pod length	P										.1103
	G										.0149

**P*≤ 0.05 P=Phenotypic correlations G=Genotypic correlations

Table 3: Estimates of direct and indirect effects on seed yield at genotypic level and phenotypic level for different traits in parents

Traits		Days to flowering	Days to Maturity	Plant height	Branches per plant	Pods per plant	Clusters per plant	Pods per cluster	Seeds per pod	100-seed weight	Pod length	Correlation with yield per plant
Days to flowering	P	-1.0100	.8908	.0152	-.0215	.4189	.0262	.0235	-.0838	.1784	.4193	.8570*
	G	-5.2343	1.2609	1.4461	-.0316	.9937	.2527	-.4064	-.2889	.7080	2.2654	.9656
Days to	P	-.9174	.9807	.0154	-.0087	.3079	.0152	.0156	-.1071	.1275	.3815	.8106*

Maturity	G	-4.8340	1.3653	1.5040	-.0112	.7893	.1580	-.3342	-.4192	.5344	2.1707	.9231
Plant height	P	-.9414	.9227	.0163	.0160	.3354	.0141	.0184	-.0784	.1463	.3939	.8432*
	G	-5.0091	1.3589	1.5111	-.0142	.8256	.1282	-.3534	-.2413	.5604	2.1855	.9518
Branches per plant	P	-.0580	.0228	-.0007	-.3739	.0976	.0058	.0067	-.1033	-.0243	.1168	-.3105
	G	-.4037	.0374	.0522	-.4096	.2291	.0916	-.0943	-.3561	.0378	.6229	-.1927
Pods per plant	P	-.7748	.5530	.0100	-.0668	.5460	.0423	.0242	-.0581	.0943	.3024	.6725*
	G	-4.3207	.8951	1.0363	-.0779	1.2039	.4300	-.3395	-.1529	.4947	1.6116	.7806
Clusters per plant	P	-.3171	.1790	.0028	-.0262	.2770	.0834	.0111	-.0514	.0040	.0471	.2098
	G	-1.7100	.2788	.2505	-.0485	.6692	.7736	-.0932	-.1349	-.0217	.2811	.2449
Pods per cluster	P	-.4825	.3103	.0061	-.0512	.2683	.0188	.0492	-.0303	.1077	.2256	.4222*
	G	-8.7496	1.8771	2.1965	-.1589	1.6814	.2965	-.2431	-.0032	1.2421	3.5247	1.6635
Seeds per pod	P	-.2816	.3497	.0043	-.1286	.1056	.0143	.0050	-.3004	.0758	.2158	.0598
	G	-1.7070	.6460	.4116	-.1646	.2078	.1178	-.0009	-.8860	.3541	1.1682	.1470
100-seed weight	P	-.6539	.4538	.0087	.0330	.1869	.0012	.0192	-.0827	.2755	.2998	.5417*
	G	-4.0635	.8001	.9286	-.0170	.6531	-.0184	-.3311	-.3440	.9120	2.1432	.6631
Pod length	P	-.9156	.8090	.0139	-.0945	.3570	.0085	.0240	-.1402	.1786	.4625	.7033*
	G	-5.0030	1.2504	1.3933	-.1076	.8186	.0917	-.3615	-.4367	.8246	2.3702	.8401

*$P \leq 0.05$ P=Phenotypic direct effcts G=Genotypic direct effects

Table 4: Estimates of direct and indirect effects on seed yield at genotypic level and phenotypic level for different traits in progeny

Traits		Days to flowering	Days to Maturity	Plant height	Branches per plant	Pods per plant	Clusters per plant	Pods per cluster	Seeds per pod	100- seed weight	Pod length	Correlation with yield per plant
Days to flowering	P	.0230	.1677	-.0275	-.0251	-.1442	.2355	-.1286	.0232	.0000	.0123	.1362
	G	-.0522	.4020	-.0029	-.1089	-.0749	.4470	-.3227	-.3470	.1864	.1518	.2786
Days to Maturity	P	.0100	.3857	.0293	-.0541	-.0754	.0810	.0378	-.0011	.0001	-.0966	.3167
	G	-.0250	.8397	.0024	-.2164	-.0392	.1447	.1097	.0185	.3424	-.7752	.4018
Plant height	P	-.0021	.0376	.3008	-.0725	-.1935	.3470	.1844	-.0106	.0000	-.0305	.5606*
	G	.0057	.0762	.0267	-.3207	-.1000	.6237	.4872	.1926	.0086	-.3074	.6925
Branches per plant	P	.0041	.1466	.1532	-.1423	-.1834	.3837	.1562	.0145	.0000	-.0119	.5208*
	G	-.0103	.3291	.0155	-.5521	-.1006	.7167	.4532	-.1772	.0864	-.1258	.6349
Pods per plant	P	.0106	.0932	.1866	-.0836	-.3119	.5063	.1256	.0071	.0000	-.0326	.5011*
	G	-.0251	.2120	.0172	-.3573	-.1554	.9013	.3118	-.0844	.0547	-.2584	.6163
Clusters per plant	P	.0087	.0505	.1688	-.0883	-.2554	.6184	.0993	.0129	.0000	.0067	.6216*
	G	-.0217	.1130	.0155	-.3679	-.1302	1.0756	.2695	-.1728	-.0739	.0306	.7377
Pods per cluster	P	-.0072	.0355	.1350	-.0541	-.0954	.1495	.4108	-.0096	.0000	-.0929	.4717*
	G	.0169	.0927	.0131	-.2518	-.0488	.2918	.9936	.1464	.0636	-.8060	.5115
Seeds per pod	P	-.0109	.0085	.0655	.0423	.0452	-.1633	.0806	-.0487	.0000	-.1064	-.0871
	G	.0315	.0271	.0089	.1701	.0228	-.3230	.2529	.5753	-.0737	-.8190	-.1272
100-seed weight	P	-.0081	-.2728	-.0058	.0197	.0378	.1005	-.0551	-.0074	-.0001	.0736	-.1178
	G	.0218	-.6435	-.0005	.1067	.0190	.1779	-.1413	.0948	-.4469	.6413	-.1707
Pod length	P	-.0014	.1843	.0454	-.0084	-.0504	-.0205	.1889	-.0256	.0000	-.2020	.1103
	G	.0055	.4533	.0057	-.0484	-.0280	-.0229	.5577	.3281	.1996	-1.4359	.0149

*$P \leq 0.05$ P=Phenotypic direct effcts G=Genotypic direct effects

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