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Genetic Variability and Path Analysis in Greengram [Vigna radiata (L.)Wilczek]

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Abstract

Analysis of variance showed significant amount of variability for all traits under study. High GCV and PCV were observed for harvest index and number of pods per plant. High heritability was observed for seed yield per plant followed by biological yield per plant harvest index, test weight, plant height, number of pods per cluster, number of pods per plant, pod length, days to maturity, number of clusters per plant, days to 50% flowering and number of seeds per pod. High heritability coupled with high genetic advance was recorded in plant height, showing that heritability might be due to additive gene effects and direct selection for this trait may be useful. Genotypic correlation coefficients were higher in magnitude than the phenotypic correlation coefficients in all the traits under study. Seed yield showed positive and significant correlation with harvest index, test weight and number of pods per plant both genotypic and phenotypic level. Path coefficient analysis showed that among the various yield contributing traits viz; harvest index followed by biological yield per plant, plant height, days to maturity, number of pods per plant, test weight, number of pods per cluster and number of seeds per pod on seed yield indicating that direct selection for these trait may be useful.

Key Words: Greengram, Environment, Traits, Selection, Genotypes, Path

INTRODUCTION

Greengram [*Vigna radiata* (L.) Wilczek] is an important annual legume belonging to family fabaceae, sub-family papilionoideae, genus *Vigna*. The genus *Vigna* has been divided to include about 170 species, 120 from Africa, 22 from Asia, and a few from other parts of the world (Ghafoor *et al*., 2001). Seven species of *Vigna* are cultivated as pulse crops specially in Asia, Africa and some parts of America (Anishetty & Moss, 1988). It is well suited to dry areas, mainly under irrigated conditions. It is self-pollinated diploid species with chromosome number 2n = 22 with an estimated genome size of 543 mega bases (Mb) (Kang *et al*., 2014). It is the native of Indo-Burma region of Hindustan centre (Vavilov, 1926). Green gram crop is widely cultivated throughout South Asia including India, Pakistan, Bangladesh, Sri Lanka, Thailand, Cambodia, Vietnam, Indonesia, Malaysia and South China. In India, it is the third most important pulse crop after chickpea and pigeon pea (Rajendra Prasad, 2006). On account of its short duration, photo-insensitivity and dense crop canopy, it assumes special significance in crop intensification, diversification, and conservation of natural resources as well as sustainability of the production system. Pulses are the major source of dietary protein of the large section of vegetarian population of the world. Its seed contains 24.2% protein, 1.3% fat and 60.4% carbohydrate. Besides their high nutritional value, they have a unique characteristic of maintaining and restoring soil fertility through biological nitrogen fixation and thus play a vital role in sustainable agriculture.

Greengram crop is widely cultivated throughout South Asia including India, Pakistan, Bangladesh, Sri Lanka, Thailand, Cambodia, Vietnam, Indonesia, Malaysia and South China. In India, it is the third most important pulse crop after chickpea and pigeon pea (Rajendra Prasad,2011) and cultivated in Rajasthan, Maharashtra, Andhra Pradesh, Madhya Pradesh and Bihar. Andhra Pradesh ranks 6th in greengram production with 0.83 lakh tones under an area of 1.13 lakh ha with productivity of 735 kg/ha according to third advance estimates of 2020-21.

Genetic variability and diversity plays a vital role in a successful breeding programme and genetic variability is essential to meet the diversified goals of plant breeding such as breeding for increasing yield, wider adaptation, desirable quality and pest & disease resistance. The phenotypic expression of a character is resultant of the interactions between genotypes and environment. Hence, the total variation needs to be partitioned into variance due to genotype (heritable) and variance due to environment (non-heritable) for assessing the true breeding behavior of the phenotype. Heritability measures the relative amount of the heritable portion of variation, while the genetic advance helps to measure the amount of progress that could be expected with selection in a character. High heritability estimates together with high genetic advance are more valid for selection than heritability estimates alone (Johnson *et al*., 1955). Estimation of genetic variability in conjunction with heritability and genetic advance gives an idea of the possible improvement of the character through selection and stability analysis provide extended are under cultivation on with adopting behavior of genotypes.

MATERIAL AND METHODS

In this study three experiments were conducted at Agricultural Research Farm, Brahamanand P.G. College, Rath, (Hamirpur) consisted of 25 diverse genotypes of Mungbean namely; Pusa Vishal, Pusa-371, HUM-12, Pusa-672, MH-218, Pusa Baisakhi, Pusa-9531, MH-2-15, TM 96-25, RMG-991, RMG-975, IPM 02-19, IPM 99-125, ML-1451, WGG-37, MH-0891, MH-521, RMG-90, PDM 96-262, AKM-9904, BDRY-1, Pusa-16, NDM-6, COGG-912 and Pusa-1431. These Genotypes were evaluated on different dates of sowing as early (01-08-19), medium (11-08-19) and late (21-08-19) in a Randomized Block Design (RBD) with three replications during *Kharif* 2019. All recommended package of practice has been followed to retain a good crop. Five competitive plants were randomly selected from each replication and tagged for recording the observations on days to 50 % flowering, days to maturity, plant height, number of branches per plant, number of pods per plant, pod length, biological yield per plant, test weight, seed yield per plant, harvest index. Analysis of Variance was calculated by formula of Panse and Sukhatme (1969) , GCV and PCV as per given formula by Burton and Devane (1952), Heritability and Genetic advance by suggested method of Allard, (1960), Johnson *et al.* (1955) and Lush, (1949). Correlation estimated as suggested by Searle, (1961), Path coefficient estimated as suggested by Wright, (1921) and as elaborated by Dewey and Lu, (1959).

RESULT AND DISCUSSION

Analysis of Variance:

The analysis of variance (Table-1.&2.) showed significance differences for twelve characters namely; days to 50% flowering, days to maturity, plant height, number of pods per plant, number of clusters per plant, pod length, number of pods per cluster, number of seeds per pod, test weight, biological yield per plant, harvest index and seed yield per plant among the genotypes and the mean performance of different genotypes had a wide range of variation for the characters.

Genetic Variability Parameters:

The high percent of genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV), (Table-3) were showed by harvest index and number of pods per plant and moderate genotypic co-efficient of variation was observed for seed yield per plant followed by plant height, biological yield per plant, test weight, number of pods per cluster and number of clusters per plant. However, low genotypic co-efficient of variation observed for pod length followed by days to 50% flowering, days to maturity and number of seed per pod. Further, the present finding showed that estimates of PCV were generally higher than their corresponding GCV for all the characters studied indicated that these traits influence by environmental factors. High heritability was recorded for seed yield per plant followed by biological yield per plant, harvest index, test weight, plant height, and number of pods per cluster, number of pods per plant, pod length, days to maturity, number of clusters per plant and days to 50% flowering. Moderate estimates of heritability were recorded for number of seeds per pod. The maximum genetic advance in percent of mean recorded plant height earns. Moderate estimates of genetic advance observed for harvest index followed by number of pods per cluster, biological yield per plant. Low estimates for days to maturity, days to 50% flowering, seed yield per plant, test weight, number of clusters per plant, pod length, number of seeds per pod and number of pods per cluster. Maximum genetic advance was recorded for plant height. While the moderate genetic advance was observed for harvest index, number of pods per cluster, biological yield per plant. Whereas, days to maturity, days to 50% flowering, seed yield per plant, test weight, number of clusters per plant, pod length, number of seeds per pod and number of pods per cluster showed low genetic advance thereby, suggesting average response for selection based on per se performance. (Garge *et.al* 2017, Krishanan *et.al* 2018, Dhanapal and Jayamani 2018, Muthuswamy *et.al* 2019 Mariyammal *et.al.* 2019, Mohammed *et al.* 2020 and Khatik ,*et.al*.,2022).

CORRELATION:

Seed yield per plant showed positive and significant correlation with harvest index, test weight and number of pods per plant. Positive and non-significant correlation observed for pod length, number of seeds per pod. Negative but significant correlation with plant height. Negative and non-significant correlation with days to 50% flowering, number of clusters per plant, days to maturity, biological yield per plant and number of pods per cluster. Days to 50% flowering showed maximum negative and significant correlation with test weight and pod length. Negative and non-significant correlation showed by harvest index, seed yield per plant, plant height, number of pods per cluster and number of seeds per pod. However significant and positive correlation with biological yield per plant, number of clusters per plant, number of pods per plant. Days to maturity showed high significant and negative correlation with plant height, number of pods per cluster. Whereas, non- significant and negative correlation with test weight, number of clusters per plant, pod length, number of seeds pod. However positive and significant correlation was observed for days to 50% flowering. Non-significant and positive correlation showed by seed yield per plant, biological yield per plant, number of pods per plant, harvest index. Plant height showed positive and significant correlation with number of pods per cluster and pod length, whereas, positive and non-significant correlation with number of seeds per pod. Significant and negative correlation recorded for number of pods per plant, test weight, seed yield per plant and days to maturity but non-significant and negative correlation for harvest index, number of clusters per plant, days to 50% flowering and biological yield per plant. Number of pods per plant showed positive and significant correlation with seed yield per plant. Positive but non-significant correlation with number of clusters per plant, number of seeds per pod, harvest index, biological yield per plant, test weight. Significant and negative correlation with number of pods per cluster and pod length. Number of clusters per plant showed positive but non-significant correlation with number pods per plant, number of seeds per pod and number of pods per cluster and significant and negative correlation showed by pod length. Non- significant and negative correlation showed by seed yield per plant, test weight, biological yield per plant and harvest index. Pod length showed positive and significant correlation with test weight. Positive but non- significant correlation with seed yield per plant, number of pods per cluster, harvest index, number of seeds per pod and biological yield per plant. Number of pods per cluster showed positive and significant with plant height. Positive but non-significant correlation with harvest index. However, significant and negative correlation with biological yield per plant whereas non-significant but negative correlation with test weight and number of seeds per pod. Number seeds per pod showed positive but non-significant correlation with test weight and harvest index. Negative but non-significant correlation with biological yield per plant. Test weight showed positive and significant correlation with harvest index. However, negative but non-significant correlation with biological yield per plant. Biological yield per plant showed significant and negative correlation with harvest index. Harvest index showed that positive and significant with seed yield per plant. Seed yield per plant showed positive and significant correlation with seed yield at phenotypic and genotypic levels. (Sandhiya and Sarvanan 2018, Kate *et al.* 2018, Manivelan *et al.* 2019, Mohammed *et al.* 2020 and Khatik ,*et.al*.,2022)

PATH COEFFICIENT ANALYSIS:

The high positive direct effect observed for harvest index followed by biological yield per plant, plant height, days to maturity, number of pods per plant, test weight, number of pods per cluster and number of seeds per pod on seed yield. High but negative direct effect exhibited by pod length, days to 50% flowering and number of clusters per plant on seed yield per plant

At the phenotypic level also the estimates of direct and indirect were generally similar to those exhibited at genotypic level with little variation in magnitude. The magnitudes of residual effects at both phenotypic and genotypic level were observed to be low. Similar results were also earlier reported by Lavanya *et al.* (2013), Eswari *et al.* (2013), Hemavathy *et al*. (2015), Sreethy *et al.* (2017), Ghimire *et al*. (2018), Manivelan *et al.* (2019).

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Table-4.1. Pooled analysis of variance for seed yield and its components charecters in Greengram [*Vigna radiata* (L.) Wilczek]

Source of variation	d.f.	Days to 50% flowering	Days to maturity	Plant height (cm)	Number of pods per plant	Number of clusters per plant	Pod length (cm)
Replication	2	2.60	1.78	1.56	1.70	0.27	0.01
Treatment	24	19.48**	65.45**	450.85**	123.66**	1.88**	1.20**
Error	48	0.57	0.64	2.21	0.82	0.03	0.01

Cont……

Source of variation	d.f.	Number of pods per cluster	Number of seeds per pod	Test weight (g)	Biological yield per plant (g)	Harvest index (%)	Seed yield per plant (g)
Replication	2	0.22	0.09	0.03	0.22	0.03	0.17
Treatment	24	0.77**	1.98**	1.97**	72.56**	189.89**	10.33**

Table 4.2. Combined analysis of mean performance for seed yield and its components characters in Greengram [*Vigna radiata* (L.) Wilczek]

S.N.	Genotypes	Days to 50% flowering	Days to maturity	Plant height (cm)	Number pods per plant	Number of clusters per plant	Pod length (cm)	Number of pods per cluster	Number of seeds per pod	Test weight (g)	Biological yield per plant (g)	Harvest index (%)	Seed yield per plant (g)
1	Pusa Baisakhi	34.33	71.11	61.15	18.29	6.51	6.73	3.81	12.04	4.09	29.53	21.25	6.27
2	Pusa Vishal	35.45	71.55	41.78	24.78	5.30	7.69	4.61	10.84	6.30	28.36	51.83	10.69
3	Pusa 371	34.67	70.11	57.36	22.15	5.56	7.61	3.28	10.87	5.25	30.71	26.02	7.99
4	RMG 991	33.67	69.45	54.98	19.42	5.87	7.22	4.26	10.68	5.19	21.03	35.37	7.44
5	RMG 975	39.44	68.00	59.11	21.84	7.12	6.82	4.09	11.72	5.05	26.98	27.00	7.28
6	Pusa 1431	40.00	72.56	53.27	20.13	6.39	6.62	4.39	11.37	4.17	31.37	19.88	6.24
7	ML 1451	41.00	76.00	52.11	22.38	7.04	7.23	3.99	11.37	3.79	35.08	21.14	7.42

8	IPM 99-125	38.55	70.44	61.85	28.73	7.83	6.75	3.96	11.97	5.44	23.24	34.28	7.96
9	IPM 02 - 19	35.78	69.78	66.82	25.89	5.82	7.46	4.27	10.71	4.78	28.00	24.34	6.81
10	Pusa 672	36.89	71.78	71.80	24.69	4.90	8.57	3.70	12.18	6.07	33.02	27.80	9.18
11	TM 96 - 25	36.22	66.67	70.78	21.20	6.33	6.70	4.17	11.68	4.24	26.74	18.10	4.84
12	MH 02 - 15	36.55	71.00	75.29	15.38	4.87	8.22	3.32	10.94	4.49	34.91	20.31	7.09
13	Pusa 9531	41.44	70.78	61.51	16.96	4.38	7.31	3.83	10.47	4.17	37.00	14.65	5.42
14	WGG 37	38.22	65.00	69.53	21.07	6.04	6.84	4.44	10.58	4.53	21.28	27.29	5.80
15	Pusa 16	39.89	82.00	56.00	19.02	5.77	6.94	3.77	10.57	4.25	27.07	25.50	6.90
16	PDM 96 - 262	40.22	81.44	46.87	20.47	5.28	8.06	4.01	11.45	5.25	19.04	33.35	6.35
17	BDRY 1	39.78	80.33	60.29	28.69	6.61	6.03	3.28	10.08	3.46	32.42	22.65	7.33
18	MH 218	36.00	68.00	61.95	19.87	5.63	6.78	3.50	11.17	5.17	23.06	37.79	8.71
19	AKM 9904	41.22	79.33	50.18	26.62	6.17	6.54	2.85	12.27	5.18	26.84	34.14	9.16
20	COGG 912	33.56	69.11	61.42	20.67	5.54	7.47	3.66	12.33	5.26	32.04	23.10	7.40
21	RMG 90	38.78	71.89	47.91	36.60	6.50	6.01	3.74	11.17	3.69	35.29	21.39	7.55
22	MH 521	34.67	67.67	36.02	43.87	5.76	6.79	2.85	11.48	5.29	29.70	29.90	8.88
23	NDM 6	41.00	77.89	33.51	32.60	5.30	6.64	2.83	11.70	5.37	30.38	25.73	7.82
24	HUM 12	36.22	72.11	35.09	25.55	6.87	7.44	3.46	10.72	6.27	35.88	17.36	6.23
25	MH 0891	38.44	74.33	79.60	28.42	5.64	7.69	4.32	11.86	3.53	28.80	27.22	7.84
	Mean	37.68	72.33	57.05	24.21	5.96	7.13	3.78	11.29	4.81	29.11	26.70	7.54
	Min.	33.56	65.00	33.51	15.38	4.38	6.01	2.83	10.08	3.46	19.04	14.65	4.84
	Max.	41.44	82.00	79.60	43.87	7.83	8.57	4.61	12.33	6.30	37.00	51.83	14.69
	SE(d)	0.61	0.65	1.21	0.74	0.14	0.08	0.06	0.25	0.06	0.15	0.27	0.04
	C.D. at 5%	1.24	1.31	2.45	1.49	0.29	0.16	0.11	0.49	0.13	0.29	0.55	0.07
	C.V. (%)	2.00	1.10	2.61	3.74	2.91	1.32	1.83	2.66	1.57	0.61	1.26	0.59

Error	48	0.05	0.06	0.01	0.03	0.11	0.02

*, ** significant at 5% and 1% level, respectively

Table-3.Pooled estimates of variability parameters for twelve characters in Greengram [*Vigna radiata* (L.) Wilczek]

Characters	PCV (%)	GCV (%)	Heritability (%)	G.A.	G.A. as % of Mean
Days to 50% flowering	6.96	6.67	91.77	4.96	13.15
Days to maturity	6.52	6.43	97.15	9.44	13.05
Plant Height (cm)	21.59	21.44	98.54	25.01	43.84
Number of pods per plant	26.69	26.43	98.04	13.05	53.91
Number of clusters per plant	13.50	13.18	95.37	1.58	26.52
Pod length (cm)	8.95	8.85	97.82	1.29	18.03
Number of pod per cluster	13.50	13.38	98.16	1.03	27.30
Number of seeds per pod	5.98	5.36	80.29	1.12	9.89
Test weight (g)	16.95	16.87	99.14	1.67	34.61
Biological yield per plant (g)	16.90	16.89	99.87	10.12	34.77
Harvest index (%)	29.82	29.79	99.82	16.37	61.32
Seed yield per plant (g)	24.61	24.61	99.95	3.82	50.67

Table-4. Pooled estimates of correlation coefficients for phenotypic (P) and genotypic (G) levels among different Characters in Greengram [*Vigna radiata* (L.) Wilczek]

Characters		Days to 50% flowering	Days to maturity	Plant height (cm)	Number pods per plant	Number of clusters per plant	Pod length (cm)	Number of pods per cluster	Number of seeds per pod	Test weight (g)	Biological yield per plant (g)	Harvest index (%)	Seed yield per plant (g)
Days to 50% flowering	P	1.000	0.586**	-0.112	0.030	0.097	-0.251*	-0.070	-0.041	-0.353**	0.101	-0.191	-0.189
	G	1.000	0.617**	-0.113	0.032	0.107	-0.279*	-0.074	-0.045	-0.366**	0.106	-0.200	-0.197
Days to maturity	P			-0.284*	0.045	-0.044	-0.043	-0.279*	-0.031	-0.181	0.053	0.023	-0.057
	G			-0.292**	0.048	-0.043	-0.046	-0.285*	-0.059	-0.182	0.054	0.023	-0.058
Plant Height (cm)	P				-0.465**	-0.123	0.264*	0.369**	0.066	-0.408**	-0.084	-0.209	-0.291*
	G				-0.472	-0.125	0.271*	0.373**	0.079	-0.411	-0.085	-0.211	-0.293

					**					**			**
Number of pods per Plant	P					0.206	-0.362 **	-0.398 **	0.141	0.073	0.124	0.134	0.298 **
	G					0.210	-0.367 **	-0.397 **	0.153	0.078	0.125	0.137	0.302 **
Number of clusters per plant	P						-0.549 **	0.127	0.134	-0.149	-0.119	-0.074	-0.157
	G						-0.569 **	0.130	0.149	-0.153	-0.121	-0.077	-0.162
Pod length (cm)	P							0.181	0.088	0.426 **	0.053	0.132	0.183
	G							0.185	0.085	0.431 **	0.055	0.132	0.185
Number of pods per cluster	P								-0.132	-0.142	-0.306**	0.154	-0.028
	G								-0.147	-0.149	-0.309**	0.155	-0.029
Number of seeds per pod	P									0.175	-0.071	0.077	0.094
	G									0.197	-0.079	0.086	0.104
Test weight (g)	P										-0.198	0.527 **	0.498 **
	G										-0.200	0.531 **	0.501 **
Biological yield per plant (g)	P											-0.600 **	-0.039
	G											-0.600 **	-0.038
Harvest index (%)	P												0.812 **
	G												0.812 **
Seed yield per plant (g)	P												1.000
	G												1.000

*, ** significant at 5% and 1% level, respectively

Table- 5. Pooled analysis of path coefficients showing the direct and indirect effect of twelve characters on seed yield at genotypic and phenotypic levels of Greengram [*Vigna radiata* (L.) Wilczek]

Characters		Days to 50% flowering	Days to maturity	Plant height (cm)	Number pods per plant	Number of clusters per plant	Pod length (cm)	Number of pods per cluster	Number of seeds per pod	Test weight (g)	Biological yield per plant (g)	Harvest index (%)	Seed yield per plant (g)
Days to 50% flowering	P	-0.049	0.032	-0.009	0.002	-0.002	0.014	-0.003	-0.002	-0.014	0.072	-0.231	-0.189
	G	-0.066	0.048	-0.010	0.002	-0.003	0.021	-0.004	-0.002	-0.019	0.076	-0.240	-0.197
Days to maturity	P	-0.029	0.055	-0.022	0.003	0.001	0.002	-0.010	-0.001	-0.007	0.037	0.028	0.057
	G	-0.041	0.077	-0.026	0.004	0.001	0.004	-0.015	-0.003	-0.009	0.038	0.027	0.058
Plant height (cm)	P	0.006	-0.016	0.079	-0.034	0.002	-0.014	0.014	0.003	-0.016	-0.060	-0.254	-0.291*
	G	0.007	-0.023	0.088	-0.035	0.003	-0.021	0.019	0.004	-0.021	-0.061	-0.254	-0.293**
Number of pods per plant	P	-0.001	0.003	-0.037	0.072	-0.003	0.020	-0.015	0.006	0.003	0.088	0.163	0.298**
	G	-0.002	0.004	-0.042	0.075	-0.006	0.028	-0.021	0.008	0.004	0.089	0.165	0.302**
Number of clusters	P	-0.005	-0.002	-0.010	0.015	-0.015	0.030	0.005	0.005	-0.006	-0.085	-0.090	-0.157
	G	-0.007	-0.003	-0.011	0.016	-0.027	0.043	0.007	0.007	-0.008	-0.087	-0.092	-0.162

per plant													
Pod length (cm)	P	0.012	-0.002	0.021	-0.026	0.008	-0.055	0.007	0.004	0.017	0.038	0.160	0.183
	G	0.019	-0.004	0.024	-0.028	0.015	-0.076	0.010	0.004	0.022	0.039	0.159	0.185
Number of pods per cluster	P	0.003	-0.015	0.029	-0.029	-0.002	-0.010	0.037	-0.005	-0.006	-0.218	0.187	-0.028
	G	0.005	-0.022	0.033	-0.030	-0.004	-0.014	0.052	-0.007	-0.008	-0.221	0.187	-0.029
Number of seeds per pod	P	0.002	-0.002	0.005	0.010	-0.002	-0.005	-0.005	0.041	0.007	-0.051	0.093	0.094
	G	0.003	-0.005	0.007	0.011	-0.004	-0.007	-0.008	0.049	0.010	-0.057	0.103	0.104
Test weight (g)	P	0.017	-0.010	-0.032	0.005	0.002	-0.023	-0.005	0.007	0.039	-0.141	0.639	0.498**
	G	0.024	-0.014	-0.036	0.006	0.004	-0.033	-0.008	0.010	0.052	-0.143	0.638	0.501**
Biological yield per plant (g)	P	-0.005	0.003	-0.007	0.009	0.002	-0.003	-0.011	-0.003	-0.008	0.711	-0.727	-0.039
	G	-0.007	0.004	-0.007	0.009	0.003	-0.004	-0.016	-0.004	-0.010	0.715	-0.721	-0.038
Harvest index (%)	P	0.009	0.001	-0.017	0.010	0.001	-0.007	0.006	0.003	0.020	-0.227	0.912	0.812**
	G	0.013	0.002	-0.019	0.010	0.002	-0.010	0.008	0.004	0.028	-0.229	0.903	0.812**

Resi = 0.0153

*, ** significant at 5% and 1% level, respectively