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Study of genetic variability parameters and character association of seed characteristics of mungbean [*Vigna radiata* (L.) Wilczek]

Anil Kumar, NK Sharma, Anita, Komal Shekhawat, Swarnlata Kumawat and Gopi Krishan Gaur

Abstract
A laboratory experiment was conducted to study genetic variability parameters and character association of seed traits with 35 genotypes of mungbean under laboratory conditions during 2020 at College of Agriculture, Swami Keshwanand Rajasthan Agricultural University, Bikaner (Rajasthan). Highly significant differences were found among genotypes for all seed traits studied which indicates the existence of ample amount of genetic variability among genotypes and therefore, signifying the scope of selection for genetic improvement of mungbean. The high degree of genetic variability along with high heritability and high genetic advance as per cent of mean were estimated for water absorption capacity, water absorption index and porosity which reveals that these characters were under the control of additive gene action and therefore, form the basis of selection for mungbean improvement programme. Among seed traits, water absorption index and 100-seed weight had positive correlation with seed yield and directly contributed towards seed yield.

Keywords: Mungbean, seed traits, variability parameters, character association

Introduction

Pulses are an important source of staple protein for vegetarians which constitute a major population of the country. Mungbean is also known as green gram, an ancient pulse crop widely cultivated under different agro-ecological situations in India mainly during *Kharif* and summer seasons. It is a diploid species having chromosome number (2n=22) belongs to family Leguminosae (Fabaceae), sub-family Papilionaceae and is botanically recognized as *Vigna radiata* (L.) Wilczek. Mungbean is a native of South Asia (India). *Vigna radiata* var. *sublobata* is the possible progenitor of mungbean. It is basically a self-pollinated crop (Singh *et al.*, 2015) [10].

Pulses play an important role in supplying the needs of food in human society, especially in developing countries. Determination of physical and mechanical properties of seeds and agricultural products is important in designing of harvesting, handling and processing equipment, transport, yield and store of the crop. Physical parameters of seed affect vegetative growth and are frequently related to yield, market grade and harvest efficiency. Some physical properties of seeds *viz*., 100-seed weight, seed volume and seed size are the important characteristics for designing equipment for the transportation of agricultural produce (Peleg, 1985) [15]. Genetic variation is the cause for variation in the size of seed between varieties. Many researchers investigated the variation on seed size for seed germination following seedling emergence and related agronomic aspects in mungbean. Generally, the larger seed has better field performance than the small seed. The 100-seed weight is one of the important character and represents the size, quality and density of seeds which are also affected by environment and genetic factors (ICARDA, 2005) [13]. Therefore, it is essential to achieve basic scientific information about these seed characteristics.

Correlation measures the degree and direction of association and also the genetic or non-genetic relationship between two or more traits which forms the basis for selection. Path analysis splits the correlation coefficient into the measures of direct and indirect effects of a set of independent variables on the dependent variable (Dewey and Lu, 1959) [4]. Therefore, the present study was conducted to assess genetic variability, heritability, genetic advance, correlation and path coefficient in mungbean for seed traits.

Material and Methods

The experimental material consisting of thirty five genotypes/ varieties were procured from NBPGR, Regional Station, Jodhpur; Rajasthan Agricultural Research Institute, Durgapura, Jaipur; Agricultural Research Station, Sriganganagar and Agricultural Research Station, Mandor, Jodhpur is given in Table-1.

Laboratory observations were recorded on seven seed traits of thirty five mungbean genotypes *viz*., 100- seed weight, seed volume, true density, bulk density, porosity, water absorption capacity and water absorption index for three replications of each mungbean genotype in completely randomized design studied at room temperature. The procedure adopted to record the observations for each character is given below:

1. **100-seed weight (g):** Well dried 100-seeds were counted from bulk seeds of each genotype and weight on electrical balance.
2. **Seed volume (µl/seed):** Seed volume was measured by liquid displacement technique (Shepherd and Bhardwaj, 1986). Water was used to determine seed volume. For each mungbean genotype 100-seeds were weighed and put into a 100 ml measuring cylinder containing 15 ml (initial reading) of water that could completely cover all the seeds. Seed volume was calculated according to Mohsenin (1986) [14] by formula:

Seed Volume (µl/seed) = (final reading – initial reading)/100

3. **True density (g/cm^3):** True density was determined using the toluene displacement method (Mohsenin, 1986; Singh and Goswami, 1996) [14, 16]. Toluene (200 ml) was filled in a 500 ml graduated measuring cylinder and 100g seeds were immersed in it. The amount of toluene displaced was recorded. The true density was estimated as the ratio of sample mass to the volume of displaced toluene.
4. **Bulk density (g/cm^3):** Bulk density was determined following the method reported by Singh and Goswami (1996) [16] and Gupta and Das (1997) [12] by filling a 500 ml cylinder with seeds from a height of 15 cm at a constant rate. Excess seeds were levelled off with a metal rod and then the contents were weighed. Bulk densities were calculated as the ratio of the mass of the sample to the volume of the container and expressed in gcm^{-3}. Tests were carried out without tapping the cylinder and compacting the seeds.

$$\text{Bulk density (g/cm}^3) = \frac{M}{V}$$

Where

M = Mass of seed in gram

V =Volume of container in cm^3

5. **Porosity (%):** The porosity of bulk seed was computed from the values of true density and bulk density using the following formula (Singh and Goswami, 1996) [16]:

$$\text{Porosity (\%)} = \{1 - \frac{\text{B.D.}}{\text{T.D.}}\} \text{ X } 100$$

Where

B. D. = Bulk density (in gcm^{-3})

T. D. = True density (in gcm^{-3})

6. **Water absorption capacity (mg/seed):** To calculate the water absorption capacity, 100 seeds from each replication were weighted, soaked in water and was maintained at room temperature for 12 hours. The seeds were then removed from water and the excess moisture on the seed surface was removed with filter paper and seeds were weighted. Water absorption capacity in terms of mg per seed was calculated as per Mohsenin (1986) [14]:

$$\text{WAC (mg/seed)} = \frac{\text{Weight after soaking - Weight before soaking}}{100}$$

Where

WAC = Water absorption capacity

7. **Water absorption index:** The water absorption index was obtained by dividing the water absorption capacity of a single seed by its size/weight (Williamsa *et al*., 1983) [18].

$$\text{Water absorption index} = \frac{\text{Water absorption capacity (mg/seed)}}{\text{Original seed size (g)}}$$

Analysis of variance was done by subjecting the data to the statistical method described by Panse and Sukhatme (1985) [9]; Singh and Chaudhary (1985). Genotypic variances and phenotypic variances were calculated according to Johnson *et al.*, (1955) [6]; Comstock and Robinson (1952) [3], respectively from the expectations of mean squares by using an ANOVA table for each character. Heritability in a broad sense was calculated as suggested by Burton and Devane (1953) [2]. The expected genetic advance for each character was calculated as suggested by Johnson *et al.* (1955) [6]. Phenotypic and genotypic correlation and path coefficients of variation were computed as per the method given by Dewey and Lu (1959) [4].

Table 1: Details of mungbean genotypes used in investigation

S. No.	Name of genotype	Year of Collection	Source of procurement
Germplasm procured from NBPGR, Regional Station, Jodhpur			
1	IC-39269	1993	Jodhpur, Rajasthan
2	IC-39300	1993	Jaswasar, Bikaner,Rajasthan
3	IC-39328	1993	Lalela, Barmer, Rajasthan
4	IC-39352	1993	Manduwa, Barmer, Rajasthan
5	IC-39399	1993	Jaspura, Palanpur, Gujarat
6	IC-39409	1993	Kapara, Banaskantha, Gujarat
7	IC-39454	1988	Surendranagar, Gujarat
8	IC-39492	1988	Dudhai, Mahesana, Gujarat
9	IC-39608	1992	Nevra, Jodhpur, Rajasthan
10	IC-39610	1992	Osian, Jodhpur, Rajasthan
11	IC-52076	1992	*

12	IC-52081	1992	*
13	IC-52082	1992	*
14	IC-52087	1992	*
15	IC-102792	1986	Banar, Jodhpur, Rajasthan
16	IC-102821	1986	Gidani, Jaipur, Rajasthan
17	IC-102857	1986	Khasur, Dholpur, Rajasthan
18	IC-103014	1986	Alampur, Kheda, Gujarat
19	IC-103059	1986	Krakas, Amreli, Gujarat
20	IC-103244	1986	Bhrwasa, Didwana, Nagaur, Raj.
21	IC-338868	1990	Sanari, Barmer, Rajasthan
Varieties/ genotypes procured from Agriculture University, Jodhpur			
22	Sweta		CSAVAT, Kanpur
23	IPM-02-3		ICAR-IIPR, Kanpur
24	IPM-02-14		ICAR-IIPR, Kanpur
25	Samrat (PDM-139)		ICAR-IIPR, Kanpur
26	GM-4		AAU, Pulse Res.Station,Vadodara
27	MH 2-15		CCSHAU, Hisar
28	MH-421		CCSHAU, Hisar
Varieties/ genotypes procured from RARI, Durgapura, Jaipur			
29	RMG-62		SKRAU-ARS, Durgapura, Jaipur
30	RMG-344		SKRAU-ARS, Durgapura, Jaipur
31	Keshwanand Mung-1 (RMG-975)		SKNAU-RARI, Durgapura, Jaipur
Varieties/genotypes procured from ARS, Sriganganagar			
32	SML-668		PAU, Ludhiana
33	SML-832		PAU, Ludhiana
34	Ganga-1		SKRAU-ARS, Sriganganagar
35	MUM-2		CCS Meerut University, Meerut

*Source was not mentioned by NBPGR, Regional Station, Jodhpur.

Table 2: Analysis of variance of mungbean genotypes for seed characteristics

S. No.	Character	Sources of variation		
		Replications	Genotypes	Error
	d. f.	2	34	68
1.	100- seed weight (g)	0.00104	0.42034**	0.00081
2.	Seed volume (µl/seed)	0.37143	70.32885**	0.24398
3.	Bulk density (g/cm³)	0.00013	0.00240**	0.00016
4.	True density (g/cm³)	0.00083	0.01712**	0.00031
5.	Porosity (%)	0.88748	76.38915**	0.98074
6.	Water absorption capacity (mg/seed)	0.09002	219.68103**	0.64371
7.	Water absorption index	0.00002	0.11217**	0.00042

*Significant at P = 0.05, ** Significant at P = 0.01

Table 3: Genetic variability parameters of mungbean genotypes for seed characteristics

S. No.	Name of character	Mean	Range	Coefficient of variation		Heritability % (broad sense)	Genetic advance at 5%	Genetic advance as per cent of mean at 5%
				Genotypic	Phenotypic			
1	100- seed weight (g)	4.17	3.53-5.34	8.97	8.98	99.80	0.77	18.46
2	Seed volume (µl/seed)	31	20-40	15.71	15.74	99.70	9.94	32.30
3	Bulk density (g/cm³)	1.04	0.98-1.08	2.62	2.71	93.20	0.05	5.20
4	True density (g/cm³)	1.35	1.14-1.55	5.54	5.59	98.20	0.15	11.31
5	Porosity (per cent)	22.54	8.28-33.25	22.24	22.39	98.70	10.26	45.53
6	Water absorption capacity (mg/seed)	24.15	7.75-41.64	35.38	35.43	99.70	17.58	72.78
7	Water absorption index	0.58	0.22-1.02	33.49	33.55	99.60	0.40	68.86

Table 4: Estimates of phenotypic and genotypic correlation coefficient of mungbean genotypes for seed characteristics

Name of character		100- seed weight	Seed volume	Bulk density	True density	Porosity	Water absorption capacity	Water absorption index	Seed yield per plant
100- seed weight	P	1.000	0.507**	-0.030	-0.130	-0.091	0.447**	0.185	0.324*
	G	1.000	0.508	-0.033	-0.131	-0.092	0.449	0.187	0.339
Seed volume	P		1.000	-0.087	-0.040	-0.002	0.302**	0.159	0.103
	G		1.000	-0.092	-0.039	-0.002	0.303	0.160	0.111
Bulk density	P			1.000	-0.102	-0.484**	-0.186	-0.204*	-0.076
	G			1.000	-0.104	-0.482	-0.191	-0.210	-0.082
True density	P				1.000	0.916**	0.139	0.191*	0.203*
	G				1.000	0.927	0.141	0.194	0.210
Porosity	P					1.000	0.207*	0.257**	0.203*

	G					1.000	0.208	0.258	0.213
Water absorption capacity	P						1.000	0.960**	0.628**
	G						1.000	0.960	0.658
Water absorption index	P							1.000	0.601**
	G							1.000	0.628
Seed yield per plant	P								1.000
	G								1.000

Table 5: Estimates of phenotypic and genotypic path coefficient of mungbean genotypes on seed yield for seed characteristics

Character		100- seed weight	Seed volume	Bulk density	True density	Porosity	Water absorption capacity	Water absorption index	Correlation with seed yield per plant
100- seed weight	P	0.7527	0.3818	-0.0227	-0.0977	-0.0688	0.3366	0.1396	0.324*
	G	0.8965	0.4557	-0.0292	-0.1178	-0.0822	0.4024	0.1675	0.339
Seed volume	P	-0.0562	-0.1107	0.0096	0.0045	0.0002	-0.0334	-0.0176	0.103
	G	-0.0372	-0.0731	0.0067	0.0028	0.0001	-0.0221	-0.0117	0.111
Bulk density	P	0.0180	0.0516	-0.5949	0.0608	0.2879	0.1104	0.1216	-0.076
	G	-0.0143	-0.0400	0.4370	-0.0454	-0.2106	-0.0835	-0.0919	-0.082
True density	P	-0.2090	-0.0648	-0.1647	1.6107	1.4753	0.2244	0.3081	0.203*
	G	0.0892	0.0264	0.0704	-0.6788	-0.6295	-0.0959	-0.1317	0.210
Porosity	P	0.1534	0.0034	0.8119	-1.5368	-1.6777	-0.3466	-0.4307	0.203*
	G	-0.0852	-0.0015	-0.4477	0.8615	0.9289	0.1932	0.2400	0.213
Water absorption capacity	P	-0.7041	-0.4753	0.2922	-0.2193	-0.3253	-1.5744	-1.5113	0.628**
	G	-0.9909	-0.6681	0.4218	-0.3118	-0.4591	-2.2077	-2.1192	0.658
Water absorption index	P	0.3692	0.3171	-0.4070	0.3809	0.5111	1.9112	1.9910	0.601**
	G	0.4811	0.4113	-0.5412	0.4996	0.6654	2.4715	2.5749	0.628

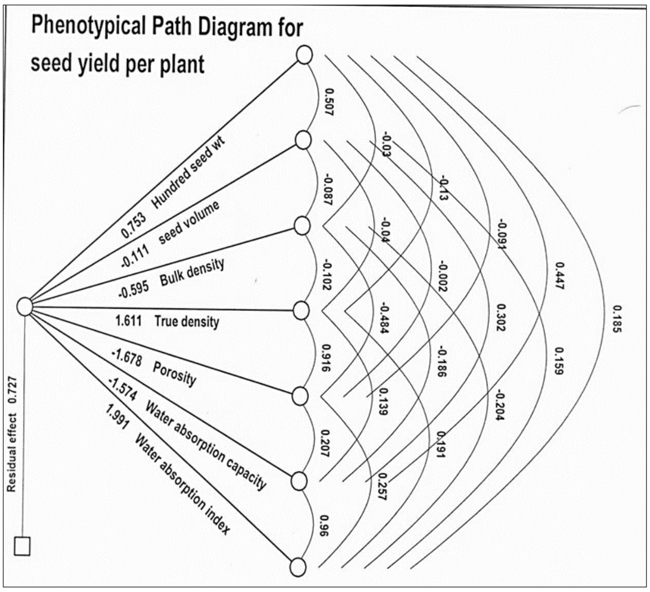

Fig 1: Phenotypic path diagram of seed traits for seed yield in mungbean

Result and Discussion

The analysis of variance revealed significant differences among genotypes for all seven seed traits which indicate the presence of good amount of variability in the genotypes and scope of selection for genetic improvement of mungbean (Table-2). The results confirmed the findings of Adlan (2019) [1] in mungbean, Get *et al.* (2019) [5] in lentil, Pal *et al.* (2020) [8] and Meena (2021) [7] in mothbean. High GCV and PCV were found for water absorption capacity, water absorption index and porosity. Therefore, high degree of heritable genetic variability in these seed traits reveals the good scope of selection for these traits (Table-3). Similar findings were earlier reported by Adlan (2019) [1] in mungbean and Get *et al.* (2019) [5] in lentil. High heritability coupled with high/moderate genetic advance as per cent of mean was observed for water absorption capacity, water absorption index, porosity, seed volume, 100-seed weight and true density. These traits are governed by additive gene action and therefore, may be improved through direct selection.

These results are accordance with the earlier finding of Adlan (2019) [1] in mungbean, Get *et al.* (2019) [5] in lentil, Pal *et al.* (2020) [8] and Meena (2021) [7] in mothbean.

The traits namely; 100-seed weight, true density, porosity, water absorption capacity and water absorption index had significantly positive correlation with seed yield per plant (Table-4). Positive direct effect on seed yield per plant was observed for water absorption index and 100-seed weight at both phenotypic and genotypic levels; whereas, true density at phenotypic level and porosity and bulk density at genotypic level (Table-5). The residual effect was found high for seed traits at both phenotypic and genotypic levels which indicate that seed traits were also contributed to seed yield but major contribution came from other traits like agro-morphological and physio-biochemical traits (Fig.1). These findings are in accordance as reported by Adlan (2019) [1] in mungbean, Pal *et al.* (2020) [8] and Meena (2021) [7] in mothbean.

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