Available online at www.ijpab.com

DOI: http://dx.doi.org/10.18782/2320-7051.2481

ISSN: 2320 – 7051

Int. J. Pure App. Biosci. **5 (1):** 543-551 (2017)

Research Article

International Journal of Pure & Applied Bioscience

OPEN ACCESS

Relationship and Genetic Variability of Seed Yield and Morpho-Physiological Traits in Mungbean (*Vigna radiata* (L.) Wilczek)

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Received: 19.01.2017 | Revised: 30.01.2017 | Accepted: 3.02.2017

ABSTRACT

Genetic variability and character association were studied in 60 mungbean genotypes for different morpho-physiological characters during summer, 2013. Highest GCV and PCV were observed for number of branches per plant, plant height, total pod weight per plant, harvest index, canopy temperature difference, membrane stability index and necrosis. Highest genetic advance as per cent of mean was recorded for necrosis, membrane stability index, plant height, number of branches per plant, biomass, total pod weight per plant, total chlorophyll content, number of pods per plant, seed dry weight per plant, harvest index and canopy temperature difference. High heritability was recorded for photochemical efficiency followed by days to maturity, membrane stability index, plant height, seed dry weight per plant, total chlorophyll content , total pod weight per plant, biomass, number of seeds per pod, days to first flowering, 100 seed weight, days to first pod, flower retention, number of branches per plant. Hence, direct selection may be exercised for improvement of these traits. Estimates of correlations revealed that seed yield had positive and significant correlation with flower retention, number of pods per plant, number of seeds per pod, biomass, pod weight per plant, seed weight per plant, harvest index, canopy temperature difference, photochemical efficiency, membrane stability index, total chlorophyll.

Key words: *Mungbean, Variability, Heritability, Genetic Advance and Correlation*

INTRODUCTION

Mungbean (*Vigna radiata* (L.) Wilczek) is an important pulse crop in Asia and is suitable for cultivation under different farming situations. Mungbean is self-pollinated crop well grown in sandy and loam soils, having soil pH 6.2 to 7.2. Its seed contains 22-28% protein, 60-65% carbohydrates, 1-1.5 % fat and 3.5-4.5% fibres. However, productivity in the country is still low and there is a need for improvement[2]. There has been considerable improvement in yield of mungbean during the past, mostly due to the empirical selection for yield per se. However, currently both potential and actual yields are leveling off in mungbean because genetic gains in yield are becoming harder to achieve, partly due to the lack of appropriate genetic variability[12,23].

Cite this article: Sunayana, Punia, M.S. and Yadav, R., Relationship and Genetic Variability of Seed Yield and Morpho-Physiological Traits in Mungbean (*Vigna radiata* (L.) Wilczek), *Int. J. Pure App. Biosci.* **5(1):** 543-551 (2017). doi: http://dx.doi.org/10.18782/2320-7051.2481

Yield is a complex character associated with various contributing characters which are interrelated among them. The levels of yield depend largely on several morphological and physiological characters. For developing suitable selection strategy the knowledge of genetic variability present in the available germplasm for yield and its associated characters is important. To accumulate optimum contribution of yield contributing characters, it is essential to know the association of various characters. Thus the study was conducted to determine the heritability, genetic advance for various traits and genotypic and phenotypic correlations among various yield components of selected genotypes.

The importance of correlation analysis is particularly appreciable when highly heritable characters associated with complex trait like yield are identified and successfully used as criteria for effective selection to achieve high yield[20]. The information on both heritability and the relationships among characters will be crucial for obtaining appropriate breeding strategies to achieve breeding goals[18]. This study was undertaken to evaluate the variability, correlation, heritability and genetic advance of twenty morphological and physiological characters.

The information achieved would be useful to arrive at certain physiological and morphological parameters that could be used as selection criteria in the mungbean breeding program for yield improvement. Furthermore, the findings will also be useful for identifying promising lines to be used as parents in the future breeding programs. The present study was undertaken to examine the nature and magnitude of genetic variability and association among characters in mungbean.

MATERIALS AND METHODS

Field layout

In the present investigation 60 mungbean genotypes were sown in randomized block design (RBD) with three replications having a plot size of 2 rows x 2m at CCS Haryana Agricultural University, Hisar and the crop was sown in April, 2013. All recommended package of practices were adopted to raise the crop, however, three irrigations were applied. Rainfall was only 2.3 mm during the crop season.

Data analysis

Observations were recorded on five randomly selected plants from each genotype in each replication for characters *viz.* flower retention, plant height, number of pods per plant, number of branches per plant, number of seeds per pod, pod weight per plant, 100-Seed weight, photochemical efficiency, relative stress injury and total chlorophyll content. Days to first flowering, days to first pod initiation, days to maturity, total biomass, seed yield, harvest index, incidence of Mungbean Yellow Mosaic Virus (MYMV), canopy temperature and necrosis were recorded on plot basis. For recording incidence of MYMV, 1 to 9 ratings scale was used. Total chlorophyll content was measured by SPAD chlorophyll meter and necrosis was recorded on visual basis on 0-4 scale where, 0-no necrosis, 1-1 to 25% necrosis, 2-26 to 50% necrosis, 3-51 to 75% necrosis and 4-76 to 100% necrosis. Canopy temperature (°C) was recorded with a hand held infrared thermometer (IRT), model AG-42, Tele temp crop, Fullerton (CA), for instantaneous measurement of canopy temperature depression. Data were recorded between 1200 hrs to 1400 hrs. Photochemical efficiency was measured by chlorophyll a florescence meter in terms of $F_{v/m}$ which was calculated as $(F_m-F_o)/Fm$, where, F_o-minimal florescence, F_m-maximal florescence and F_v-variable florescence. Relative stress injury (RSI) was calculated as a ratio of electrical conductivity before boiling (EC_1) to the ratio of electrical conductivity after boiling (EC_2) and expressed in percentage.

$$\text{RSI}\ (\%) = \frac{EC_1}{EC_2}\ x\ 100$$

To measure membrane thermo stability, method of Ibrahim and Quick[9,10] was followed. A random sample of leaves from five plants from each replication was collected. Membrane Stability Index was expressed in percentage and calculated by the following formula:

$$MSI = 1 - \frac{T_1}{T_2} \times 100$$

where;

T_1=conductivity reading after heat treatment

T_2=conductivity reading after autoclaving

Statistical Analysis

The data for different characters were statistically analyzed to work out genotypic and phenotypic coefficients of variation[6] based on the estimate of genotypic and phenotypic variance. Heritability in broad sense was calculated as per the formula suggested by Hanson *et al*[8]., and expected genetic gain as suggested by Johnson *et al*[11]. Correlation coefficients at phenotypic and genotypic level were calculated as per procedure given by Al-Jibouri *et al*[1].

RESULTS AND DISCUSSION

The analysis of variance revealed highly significant differences among 60 genotypes of mungbean for all the morphological and physiological characters studied except for incidence of MYMV (Table 1). This indicated that there was considerable variability among the genotypes of mungbean for all the characters except incidence of MYMV. Rao *et al*[21]., Bharti *et al*[4]., and Mehndi *et al*., also observed a wide spectrum of variation for yield and yield components in mungbean. Contrarily, Dhananjay *et al*[7]., reported less genetic variability for pods per cluster, seeds per pod, days to 50 % flowering, pods per plant. Similarly Aziz *et al*[3]., observed that primary and secondary branches, pods per cluster and pod length showed lesser variability while 100-seed weight and harvest index exhibited intermediate range of variability and sufficient genetic variability was observed for plant height, pods per plant, total plant weight and seed yield. Thus, there is ample scope for selection of different quantitative characters for crop improvement. Johnson *et al*[11]., has suggested that GCV together with heritability would give best picture of amount of advance to be expected from selection.

The mean, range, coefficient of variation, heritability, genetic advance and genetic advance as per cent mean of morpho-physiological characters are given in Table 2. The phenotypic coefficients of variation were higher than the respective genotypic coefficients of variation indicating the effects of environment in expression of these traits. The range of PCV for different traits was observed from 4.448 (days to maturity) to 82.419 (necrosis) whereas GCV for different traits ranged from 4.011 (number of pods per plant) to 49.945 (necrosis). The presence of wide range of PCV and GCV under water stress regime revealed the larger extent of phenotypic and genetic variability. Number of branches per plant, plant height, total pod weight per plant, harvest index, canopy temperature difference, membrane stability index and necrosis exhibited high genotypic and phenotypic coefficient of variation. The presence of wide range of PCV and GCV revealed that these traits can be used for selection as they respond well because of the larger extent of phenotypic and genetic variability. Similar findings were also reported by Marappa *et al*[15]., and Narasimhulu *et al*[17]., in mungbean for many of these traits. Low values of PCV and GCV were observed for Days to first flowering, Days to first pod, Flower retention, Number of seeds per pod and photochemical efficiency. Khedar *et al*[13]., also observed low values of PCV and GCV for days to maturity, days to 50 per cent flowering, seeds per pod. Genotypic coefficient of variation measures the amount of variation present in a particular character. However, it does not determine the proportion of heritable variation present in the total variation. Therefore, heritable variation existing in the character can be find out with greater degree of accuracy with heritability in combination with genetic advance. Parameswarappa[19], indicating that mungbean seed yield expressed high genetic advance coupled with high heritability and genotypic coefficient of variation.

High heritability was recorded for photochemical efficiency followed by days to maturity, membrane stability index, plant height, seed dry weight per plant, total chlorophyll content , total pod weight per plant, biomass, number of seeds per pod, days to first flowering, 100 seed weight, days to first pod, flower retention, number of branches per plant. This indicated the preponderance of additive gene action in the expression of all these traits. Similar results have also obtained by Rao *et al*[21]., and Biradar *et al*[5]., substantiating the results obtained in this study. Genetic advance as per cent of mean ranged from 7.546 to 62.349 per cent. Highest genetic advance as per cent of mean was recorded for necrosis, membrane stability index, plant height, number of branches per plant, biomass, total pod weight per plant, total chlorophyll content, number of pods per plant, seed dry weight per plant, harvest index and canopy temperature difference which were in confirmation of the results obtained Rao *et al*[21]., and Reni *et al*[22]. Moderate genetic advance as per cent of mean for photochemical efficiency, number of seeds per pod, 100 seed weight, grain yield per plot and flower retention were observed. The traits exhibiting high heritability coupled with high genetic advance can be improved by direct selection. Low heritability coupled with low genetic advance and low GCV suggested presence of non-additive gene action and high GXE interaction. Mehandi *et al*[16]., also indicated that plant height, number of clusters per plant and number of pods per plant exhibited high heritability coupled with high to moderate genetic advance and days to 50% flowering, number of branches per plant, days to maturity, seed yield per plant showed high to moderate heritability coupled with moderate to low genetic advance.

The genotypic correlation coefficients, in general, were higher than the phenotypic correlation coefficients which indicated masking of modifying effects of environment and also the presence of strong association between the two corresponding characters (Table 3). This also indicated that the selection for these characters might be rewarding. Further, the seed yield was positively associated with all characters except days to flowering, pod initiation, days to maturity and plant height. Thus, it may be inferred that the selection based on these traits either in combination or alone would be beneficial to identify the genotypes having better yield potential. Similar views have been reported by Srivastava *et al*[24]., Dhananjay *et al*[7]., Narasimhulu *et al*[17]., and Reni *et al*[22]. Days to maturity showed positive association with days to first flowering, days to first pod, biomass and total chlorophyll content but number of pods per plant, seed weight per plant, seed yield per plot, harvest index and canopy temperature difference were negatively correlated which was in conformity with the findings of Bharti *et al*[4]. Flower retention showed positive correlation with number of pods per plant, biomass, seed weight per plant, seed yield per plot and harvest index but negative with canopy temperature difference. Number of pods per plant showed positive association with flower retention, number of branches per plant, pod weight per pant, seed weight per plant, seed yield per plot, biomass and harvest index but negative association with pod Initiation, number of seeds per pod, days to maturity and100 seed weight. Srivastava *et al*[24]., reported that number of pods per plant had negative correlation with days to 50 % flowering and days to maturity. Kumar *et al*[14]., observed high correlation for pods per plant and harvest index. Canopy temperature difference was positively correlated with biomass, pod weight per plant, seed yield per plot, seed weight per plant, membrane stability index and total chlorophyll content whereas days to first flowering, plant height, flower retention, days to first pod, and days to maturity, 100 seed weight and photochemical efficiency showed negative correlation. Membrane stability index was found to be positively correlated to pod weight per plant, seed yield per plot, seed weight per plant, 100 seed weight, canopy temperature difference, photochemical efficiency and total chlorophyll content.

Table1: Analysis of Variance (ANOVA) for twenty characters in mungbean

		Mean sum of squares									
Source of variation	**Degrees of freedom**	**Days to first flowering**	**Days to first pod**	**Flower retention (%)**	**Plant height (cm)**	**No. of pod/plant**	**No. of branches/plant**	**No. of seeds/pod**	**Days to maturity**	**Biomass (g)**	**Pod weight/plant (g)**
Replications	2	9.516	13.216	32.021	24.387	16.330	0.463	0.105	10.905	6854.755	3.467
Treatment	59	11.483**	12.912**	181.304**	200.243**	101.697**	1.136**	3.224**	22.749**	30644.880**	9.405**
Error	118	0.861	1.329	20.411	6.351	14.545	0.143	0.196	0.476	1804.987	0.533

Continued…

ANOVA											
		Mean sum of squares									
Source of variation	**Degrees of freedom**	**Seed weight/plant (g)**	**Grain yield/plot**	**Harvest index (%)**	**100 seed weight**	**CTD (°C)**	**PE**	**MSI (%)**	**TCC**	**Necrosis (0-4) scale**	**MYMV (1-9) scale**
Replications	2	0.395	75.705	0.001	0.141	0.694	0.002	46.326	11.890	0.200	0.438
Treatment	59	4.694**	1085.345**	0.004**	0.920**	2.211**	0.009**	333.854**	145.978**	2.592**	0.297
Error	118	0.208	240.406	0.00079	0.073	0.738	0.000	9.088	7.012	0.945	0.229

* Significant at p= 0.05, ** Significant at p= 0.01

CTD- Canopy Temperature Difference, PE- Photochemical Efficiency, MSI- Membrane Stability Index, TCC- Total Chlorophyll Content, MYMV- Mungbean Yellow Mosaic Virus

Table 2: Estimates for grand mean, C.V, heritability, genetic advance and genetic advance as percent of mean for twenty characters in mungbean

Characters	Mean	PCV (%)	GCV (%)	Heritability (h^2) (%)	Genetic advance	Genetic advance as % of mean
Days to first flowering	42.767	4.906	4.400	80.434	3.476	8.129
Days to first pod	46.267	4.924	4.247	74.384	3.491	7.546
Flower retention (%)	84.209	10.218	8.697	72.433	12.839	15.247
Plant height (cm)	49.440	17.041	16.261	91.052	15.803	31.963
No. of pods/plant	19.234	20.230	4.011	39.30	4.671	24.285
No. of branches/plant	3.304	20.841	17.414	69.812	0.990	29.972
No. of seeds/pod	9.994	10.990	10.053	83.673	1.893	18.943
Days to maturity	63.194	4.448	4.312	93.973	5.441	8.610
Biomass (g)	631.049	16.933	15.537	84.192	185.327	29.368
Total pod weight/plant (g)	11.664	16.018	14.743	84.713	3.261	27.953
Seed dry weight/plant (g)	9.953	13.114	12.286	87.765	2.360	23.710
Grain yield/plot (g)	148.899	15.345	11.271	53.950	25.393	17.054
Harvest index (%)	24.04	18.108	13.835	58.375	0.052	21.776
100 seed weight (g)	5.196	11.477	10.228	79.427	0.976	18.778
Canopy temp. difference (°C)	-4.550	24.373	15.397	39.907	0.912	20.037
Photochemical efficiency	0.580	9.699	9.651	99.005	0.115	19.782
Membrane stability index (%)	53.036	20.425	19.618	92.225	20.587	38.817
Total chlorophyll content	48.026	15.207	14.172	86.851	13.066	27.207
Necrosis	1.483	82.419	49.945	36.723	0.925	62.349
Mungbean Yellow Mosaic Virus	1.189	42.269	12.671	8.986	0.093	7.824

Table 3: Estimates for Genotypic and Phenotypic Correlation Coefficient of sixty mungbean genotypes for different characters under irrigated condition

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
1	1	0.900	0.101	0.125	0.142	0.417	-0.117	0.697	0.231	0.052	-0.310	-0.472	-0.625	0.001	-0.299	-0.137	-0.005	0.142	0.119	0.108
2	0.840**	1	0.125	0.132	-0.262	0.467	-0.131	0.579	0.196	0.129	-0.218	-0.452	-0.544	0.003	-0.060	-0.003	-0.067	0.267	-0.127	0.117
3	0.089	0.145	1	0.131	0.252	0.189	0.119	0.110	0.372	0.142	0.307	0.252	0.257	0.130	0.264	0.131	-0.047	0.195	-0.021	0.126
4	0.112	0.115	0.140	1	-0.108	0.134	0.046	0.115	0.449	0.142	-0.060	-0.172	-0.649	0.135	-0.549	-0.057	0.020	0.322	-0.031	0.129
5	-0.137	-0.162*	0.248**	-0.106	1	0.414	-0.659	-0.319	+0.181	0.557	0.614	0.191	0.215	-0.278	0.129	0.254	0.128	0.120	0.135	0.082
6	0.296**	0.323**	0.093	0.101	0.198**	1	-0.049	0.125	0.291	0.181	-0.143	-0.091	-0.138	-0.142	-0.103	0.057	-0.128	-0.103	0.138	0.039
7	-0.067	-0.090	0.113	0.061	-0.474**	-0.024	1	-0.133	0.317	0.127	0.393	0.315	-0.120	-0.442	-0.100	-0.005	0.125	-0.091	0.140	0.118
8	0.597**	0.484**	0.092	0.121	-0.263**	0.108	-0.121	1	0.393	0.065	-0.198	-0.232	-0.660	0.123	-0.352	-0.068	0.116	0.385	0.092	0.129
9	0.187*	0.169*	0.363**	0.415**	+0.158*	0.251**	0.260**	0.366**	1	0.288	0.380	0.532	-0.731	-0.213	0.439	0.365	0.136	0.326	-0.156	0.114
10	0.056	0.112	0.122	0.139	0.224**	0.163*	0.115	0.072	0.266**	1	0.518**	0.508	0.082	0.102	0.309	0.362	0.277	0.514	-0.090	0.112
11	-0.247**	-0.178*	0.287**	-0.043	0.372**	-0.099	0.329**	-0.178*	0.352**	0.474**	1	0.825	0.206	0.036	0.219	0.382	0.221	0.381	-0.029	0.021
12	-0.290**	-0.260**	0.201**	-0.158*	0.181*	-0.085	0.247**	-0.182*	0.421**	0.352**	0.600**	1	0.473	0.104	0.286	0.495	0.265	0.249	-0.098	0.093
13	-0.408**	-0.346**	0.249**	-0.478**	0.186*	-0.105	-0.065	-0.521**	-0.614**	0.043	0.152*	0.438**	1	-0.136	0.497	-0.003	-0.009	-0.119	0.110	0.105
14	-0.006	-0.013	-0.133	0.121	-0.217**	-0.127	-0.348**	0.098	-0.154*	0.076	0.017	0.078	-0.063	1	-0.113	0.223	-0.042	0.379	-0.105	0.014
15	-0.152*	-0.075	-0.187*	-0.303**	0.001	-0.129	-0.123	-0.232**	0.259**	0.293**	0.219**	0.256**	0.238**	-0.026	1	-0.068	0.010	-0.100	-0.205	0.135
16	-0.119	0.002	0.108	-0.058	0.119	0.052	0.000	-0.056	0.332**	0.344**	0.351**	0.365**	0.001	0.197**	0.049	1	0.202	0.366	-0.260	0.052
17	-0.005	-0.056	-0.029	0.026	0.087	-0.125	0.115	0.100	0.121	0.241**	0.199**	0.204**	0.026	-0.031	0.005	0.196**	1	0.156	-0.310	0.082
18	0.139	0.227**	0.147*	0.292**	0.068	-0.092	-0.079	0.339**	0.261**	0.427**	0.344**	0.158*	-0.107	0.305**	-0.049	0.333**	0.169*	1	-0.497	0.123
19	-0.107	-0.120	-0.035NS	-0.089	0.086	0.017	0.068	0.087	-0.126	-0.046	0.015	0.062	0.135	-0.099	-0.238	-0.160*	- 0.261**	- 0.279**	1	0.141
20	0.097	0.105	0.055NS	0.125	0.010	0.053	0.029	0.135	0.130	0.070	-0.030	-0.076	-0.110	0.007	0.124	-0.068	0.085	0.115	-0.131	1

CONCLUSION

The information about nature and magnitude of genetic variability existing in the available genotypes of a crop is essential for selection of diverse parents which upon hybridization may provide a wide spectrum of gene recombinations of quantitatively inherited traits. High estimates of heritability and high genetic advance observed for most of the characters whereas Flower retention, No. of pods/plant, No. of seeds/pod, biomass, pod weight/plant, seed weight/plant, harvest index, canopy temperature difference, photochemical efficiency, membrane stability index, total chlorophyll content showed positive and significant correlation with seed yield. It is concluded that these characters are the most important contributing factors to seed yield and should be used as selection criteria for yield improvement in mungbean.

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