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Research Article

Studies on variability parameters and correlations in Soybean (*Glycine max*) germplasm for seed quality characters

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Abstract

Eighty-four soybean germplasm lines were tested for seed quality traits. The analysis of variance was performed and all the germplasm lines significantly differed for the characters viz., Percentage of germination, Seedling vigour index-I, Field emergence percent, Seedling vigour index-II, Electrical conductivity, and Moisture percentage. The correlation and variability studies were done for quality parameters in seed for eighty-four germplasm lines and results obtained were noted with high heritability and genetic advance along with large variability for Seedling vigor index-I, Seedling vigor index-II and electrical conductivity of seed leachates. The percentage of germination exhibited positive correlation with Seedling vigor index I and II along with field emergence and negative correlation with electrical conductivity. Genotypes GP-186, ASB-135, GP-142, GP-104, GP-145, ASB-114, ASB-15, ASB-104, GP-174, ASB-101, ASB-139, Aisb-50, Basara, Js-335 and Js-93-05 recorded superior seed quality parameters.

Keywords correlation coefficients, germination, heritability, seed quality

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Introduction

Soybean is an important crop with high nutritional content, which includes 20% oil along with 40% protein and contributed 58% of vegetable oil in total world production. India is sixth in production with 11.23 million tonnes and fourth in area with 12.12 million hectares accounting for 8.86% of the global area in 2020-2021 [1].

The identification of variability for the genetically governing characters in the germplasm lines is the prerequisite for breeding programs. Seed quality traits need to be taken into consideration by the breeders along with agronomic traits since new cultivars with better germination capacity are highly suitable for seed production and in turn preferred by the farmers. Good seed quality is the utmost important factor considered for optimum field stand [2]. The important seed quality parameter is seed vigour, which affects seed germination, seedling growth, seed quality, and resistance to adverse conditions during crop growth. High vigoured seed significantly improves the uniformity and speed of germination along with increased crop stand. Low quality seeds with less germination percent and vigour are important factors for reduced yields in soybean. Determining vigour before sowing is crucial because high vigour seeds are necessary for good field emergence [3]. Soybean genotypes have a very limited genetic variation, which

makes it necessary to create variability by using the genetically varied parents with high heterotic effects and selecting desirable segregates which can significantly alter soybean crops for both agronomic and quality attributes [4]. Seed quality traits are majorly governed by quantitative and qualitative traits which shown abundance in values of PCV and GCV. For primary selections attention should be given to traits with high genotypic variations for varietal development [5]. Larger Genetic advances joined with greater heritability indicated phenotypic selection might be utilized for the improvement of seed quality traits [6].

To identify the better germplasm lines for seed quality parameters the variableness and heritability often there in the crop need to be identified which in turn is used for crop improvement programmes in soybeans.

Methodology

This investigation was carried out at STL (Seed Testing Laboratory) of DSST, PJTSAU. Eighty-four soybean cultivars had been sown in CRD with two replicas. The germplasm lines include indigenous and exotic collection, advanced breeding lines as well as released varieties collected from the Agricultural research station, Adilabad. The data were recorded on six quality traits *viz*., seed germination percent, SV-II (seedling vigour index-II), EC (Electrical Conductivity), seed moisture percent, SV-I (seedling vigour index-I), and field Emergence %.

Seed Germination percent (%)

The test for germination analysis was directed by adopting the between paper method (BP) according to the procedure of ISTA [7]. Four replications each with 100 seeds were taken for the test. After placing the seed in between germination papers they were kept in the seed germinator where in constant temperature of 25 ± 2 °C and 90 % humidity were maintained. On 7th day ultimate count was taken and the procedure for germination% was calculated by the formula:

$$\text{Seed germination (\%)} = \frac{\text{Normal number of seedlings obtained}}{\text{Number of total seeds sown}} \text{ X } 100$$

Seedling Vigour Index -II

The SV-II was intended by process given by Abdul-Baki and Anderson [8] and values were noted in whole numbers. From the germination test conducted, about normal ten seedlings were chosen randomly placed in butter covers, and kept at 80 ± 1 °C for 24 h in hot air oven. After taking out from the oven, immediately dried seedlings were kept in a desiccator for cooling. The weight of dried seedlings was considered and stated in milligrams.

S.V-II = percent germination X Dry weight of seedlings (mg)

EC (Electrical Conductivity test (µS cm^{-1}g^{-1})

EC was taken as per the procedure mentioned in Seed Testing Rules [7]. Three replicates of 50 seeds each drawn randomly from pure seed fraction was weighed to two decimal places. Cleaned conical flasks were used to not affect the conductivity of the samples. We have added 250 ml of distilled water with conductivity of water less than 5 µS cm-1 to the containers and covered them with aluminum foils to avoid contamination. The containers were placed at 20 ± 2 °C for 18-24 h prior to placing the seeds in the water. Seed samples were weighed and placed into the prepared containers and swirled gently to completely immerse all the seeds. Each container was covered and placed at 20 ± 2 °C for 24 h in an incubator. Later, the containers were swirled gently to mix the leachates, and a conductivity meter was employed to note down the readings. Deionized water readings were

documented as control reading. EC was calculated by the following formula:

$$\text{Electrical conductivity } (\mu S\ c\bar{m}^{1}\bar{g}^{1}) = \frac{\text{Conductivity reading } (\mu S\ c\bar{m}^{1}) - \text{control reading}}{\text{Weight of replicate (g)}}$$

Seed moisture percent (%)

Moisture percent was determined as per ISTA standard procedures [7]. In a hot air oven, coarsely grounded five grams of seed material was placed at 103 °C for 17 hours. The samples which were dried were kept in the desiccator for about one hour and moisture content was assessed by the formula presented as,

$$\text{Seed Moisture percent } (\%) = \frac{W_2 - W_3}{W_2 - W_1} X100$$

Where:

W_1= Metal container weight in grams along with the lid

W_2= Metal container weight in grams along with the lid and sample before drying

W_3= Metal container weight in grams along with the lid and dried sample

Seedling vigour index-I

Ten seedlings were randomly taken after the germination test from each replication and recorded seedling length in cm and SVI-I was calculated using the below formula [8]

$$\text{SVI} = \text{Average length of seedling (cm) X Germination\%}$$

Field Emergence (%)

100 seeds were taken for each replication and sown in the field and seedling emergence percent was considered through the method given below:

$$\text{Percent field emergence} = \frac{\text{Number of emerged saplings}}{\text{Number of seeds sown}} \text{ X } 100$$

Statistical analysis

Standard statistical software R was taken to study the analysis of variance, for genotype and phenotype variations, heritability, and genetic advance progress. The correlations for genotype and phenotype were related using diverse variances and intended conferring to Burton and Devane [9]. Heritability was assessed using Jain and Allard's formula [10].

Results and Discussion

The ANOVA revealed the existence of variation among eighty-four genotypes for all seed quality parameters recorded i.e., germination percent, SVI-1, SVI-II, percent field emergence, moisture percent, and electrical conductivity (Table.1). The treatment means were high for SVI-I followed by field emergence percent, SVI-II, and germination %. [11-12] also recorded the higher mean sum of squares for the above-mentioned characters in soybean. Maximum and minimum for different seed quality parameters in eighty-four soybean genotypes were depicted in Table 2. Maximum range was observed for the characters VI-I and II.

The genotypic variance was documented and it was extremely larger for seedling vigour index-I (132737.7) next followed by Electrical conductivity (1831.15), seedling vigour index-II (389.0716), field emergence (123.6949), germination % (48.582) and seed moisture % (0.6521) (Table 3). [5, 13-14] also reported high genetic variability for the above mentioned characters in

Table 1. ANOVA table for seed quality parameters in eighty-four soybean germplasm lines

Parameters	TMSS	EMSS
Germination %	99.753**	2.756
Moisture %	1.3106*	0.00654
Seedling Vigour Index -I	266108.7**	626.9
Seedling Vigour Index-II	780.055**	1.986
Field emergence	3676.33**	13.91
Electrical conductivity	251.174**	3.821

TMSS: Treatment mean sum of squares, EMSS: Error mean sum of squares

Table 2. Descriptive parameters for seed quality traits in eighty-four soybean genotypes

Descriptive parameters	Minimum	Maximum	Mean
Germination %	51	93	81
Moisture %	6.3	9.6	8.1
Seedling vigour index-1	1045.00	2567.8	1999.2
Seedling vigour index-2	48.6	129.030	89.2
Field Emergence	40	94	76.7
Electrical Conductivity	122.37	301.98	187.9

* Significant at 0.05% , ** significant both at 0.01% and 0.05%

Table 3. Genetic parameters for seed quality characters for eighty-four lines of soybean

Seed Quality Traits	Vg	Vp	PCV %	GCV %	H2b	GA	GAPM
Germination %	48.582	51.1703	8.8305	8.6045	0.94	13.9907	17.2712
Moisture %	0.6521	0.6586	10.042	9.975	0.9901	1.6553	20.4478
Seedling vigour index-I	132737.7	133371.004	18.2679	18.2245	0.9953	748.73	37.4533
Seedling vigour index-II	389.0716	390.9834	22.1648	22.1105	0.9951	40.5338	45.4361
Field Emergence	123.6949	127.4795	14.7133	14.49	0.9703	22.5683	29.4095
Electrical Conductivity	1831.15	1845.17	22.8583	22.771	0.9924	87.81	46.7301

Vp= Phenotypic variance, Vg= Genotypic variance, GCV = Genotypic coefficient of variation, PCV= Phenotypic coefficient of variation, h2b (percent) = broad sense heritability, GA= Genetic advance, GAPM= Genetic advance as percent mean.

soybeans. Hence selection based on genotypic variance for these characters will be effective in crop improvement. High phenotypic variance (>20%) was recorded for the characters seedling vigour index-I (133371.004), electrical conductivity (1845.17), seedling vigour index-II (390.9834), field emergence (127.4795), and germination % (51.1703) (Table 3). Phenotypic based selections for the above traits would be useful in seed quality improvement in soybean as reported by different researchers [15-16].

Further high (>20%) percentages of both GCV as well as PCV were observed for parameters viz., seedling vigour index-II (22.1105, 22.1648) and electrical conductivity (22.771, 22.8583) which are in conformity with studies of Naik et al., and Syiem et al., [13, 17]. GCV and PCV estimates were moderate (10-20%) for moisture % (9.975, 10.042), seedling vigour index-I (18.2245, 18.2679), and field emergence (14.49, 14.7133). Germination % has shown low (< 10%) GCV and PCV estimates (8.6045, 8.8305). The PCV and GCV difference was less for SV-I (0.0434), SV-II (0.054), moisture % (0.067), and electrical conductivity (0.087) therefore these traits are not affected by environmental factors (Table 3). Maximum heritability (>60%) was shown for the traits Vigour Index-I (0.9953), followed by Vigour Index -II (0.9951), electrical conductivity (0.9924), field emergence (0.9703), germination% (0.94) and moisture% (0.9901). The higher genetic advance (>20%) was observed for vigour index-I (37.4533), vigour index-II (45.4361), EC (46.7301), and field emergence (29.4095). Reasonable medium values i.e., (10-20%) genetic advance was recorded for characters such as germination % (17.2712) and moisture (20.4478) (Table 3). Both genetic advance and heritability were observed high for the characters Vigour-I and II which was also reported by different researchers [6, 17-18] in soybean crop.

A high range of genetic advance united with larger heritability values were recorded for Seed vigor Index-I (0.9953), Seed vigor Index- II (0.9951), EC (0.9924), and field emergence (0.9703) revealing additive gene action effects for these characters and giving further scope to enrich variation in these parameters. The above said results agreed with Ramyashree et al., [11]. Less values of genetic advance accompanied by a higher range of heritability values were set down for percent germination and % moisture which revealed the existence of non-additive action of genes therefore, heterosis breeding could be used for the progression of these traits and the results are in accordance with Aditya et al., [19]. Hence it is important to study correlations among diverse seed quality traits where the values are presented in Table 4 and Figure 1.

Table 4. Descriptive parameters for seed quality traits in eighty-four soybean genotypes

Traits		Germination %	Moisture %	VI-I	VI-II	FE	EC
Germination %	rp	1.000	0.1168NS	0.8264**	0.6743**	0.6965**	-0.785**
	rg	1.000	0.1223NS	0.8512**	0.6955**	0.7298**	-0.8117**
Moisture%	rp		1.000	0.0014 NS	-0.0582 NS	0.2462**	-0.1065 NS
	rg		1.000	0.00175NS	-0.0584NS	0.2499*	-0.1068NS
Seedling vigour index-I	rp			1.000	0.6245**	0.6581**	-0.7467**
	rg			1.000	0.627**	0.6706**	-0.7507**
Seedling vigourindex-II	rp				1.000	0.635**	-0.5701**
	rg				1.000	0.6474**	-0.5752**
Field Emergence	rp					1.000	-0.5207**
	rg					1.000	-0.5305**
Electrical Conductivity	rp						1.000
	rg						1.000

** showing significance at 0.01%, * showing significance at 0.05%, NS: No significance

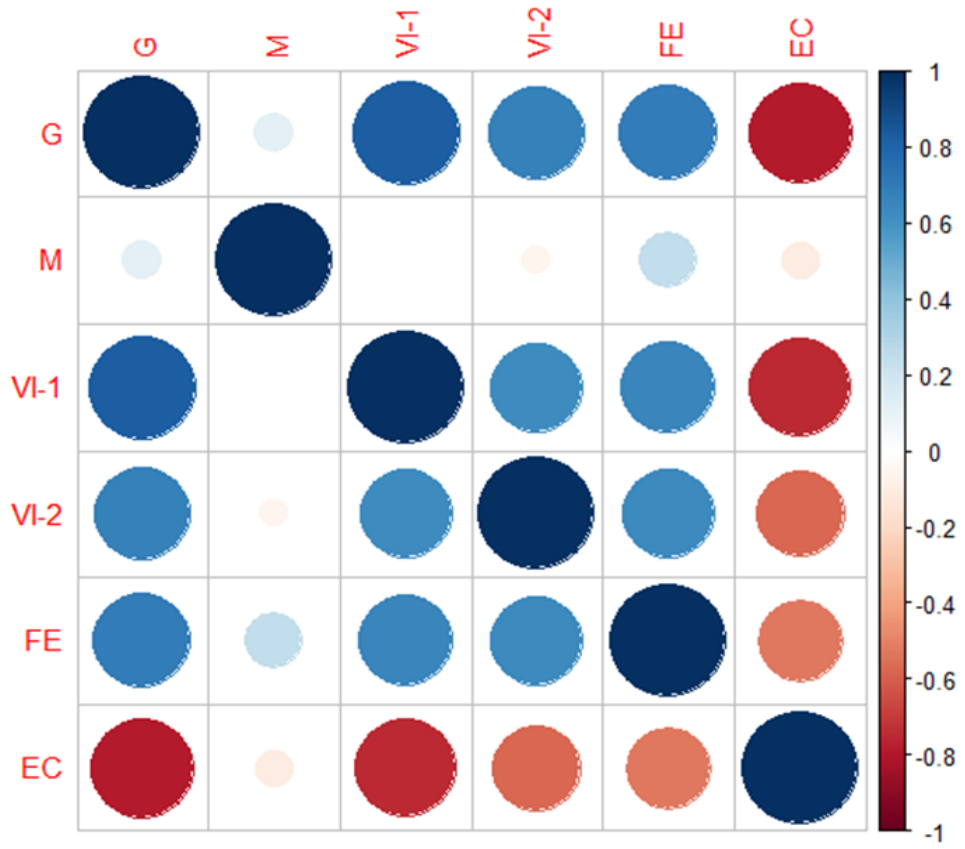

Figure 1. Diagrammatic representation of correlation coefficients for characters studied in soybean genotypes for seed quality

(G: Germination %, M: Moisture %, VI-1: Seedling Vigour Index-I, VI-2: Seedling Vigour Index-II, FE: % Field Emergence and EC: Electrical Conductivity)

The stipulated results concluded that genotypic correlation was higher than phenotype for all the parameters studied. The germination % had recorded significantly higher positive correlations with Vigour Index-I, Vigour Index-II, and percent fieldemergence as reported by [20-25,], hence choosing for these characters will definitely result in improvement of seed quality in soybean varieties. Electrical conductivity has shown a negative correlation with vigour index-I and II, field emergence, germination %, and moisture % [26-29].

The genotypes with superior performance for seed quality based on germination percentage are depicted in Table 5 and Figure 2. The eighty-four genotypes have shown higher variability for seed quality traits studied. Seed quality is the major constraint in soybean seed production, the selection of germplasm lines with high vigor and quality [30] needs to be identified so that they can be exploited in the advancement of new varieties with maximum seed quality in breeding programs.

Table 5. Seed quality characters of best cultivars in present study

Genotypes	Germination (%)	Moisture (%)	Vigour Index-I	Vigour Index-II	Field Emergence (%)	EC
GP-186	92.5	6.35	2390.1	120.4875	91.5	130.9212
ASB-135	91.5	8.55	2493.7	121.6615	91.5	140.8848
GP-142	90.5	7.85	2536.671	122.1215	93.5	137.3885
GP-104	90	8.65	2558.6	123.7795	87.5	131.8355
GP-145	90	7.15	2504.25	121.83	90.5	133.8055
ASB-114	89.5	6.65	2521.3	117.33	83.5	140.862
ASB-15	89.5	8.9	2505.9	127.243	86.5	148.3174
ASB-104	89	7.65	2383.1	121.405	83	142.3345
GP-174	88	7.55	2434.8	90.665	84	145.9233
ASB-101	87.5	6.65	2394.65	111.344	85	139.632
ASB-139	87	8.65	2206.5	109.0785	85.5	166.1111
AISB-50	85.5	8.45	2010.8	119.181	82.5	141.259
BASARA	84	8.25	2037.8	101.841	82.5	178.7274
JS-335	88.5	8.15	2282	124.375	90	158.056
JS-93-05	84.5	8.35	2307	119.662	83.5	179.6195

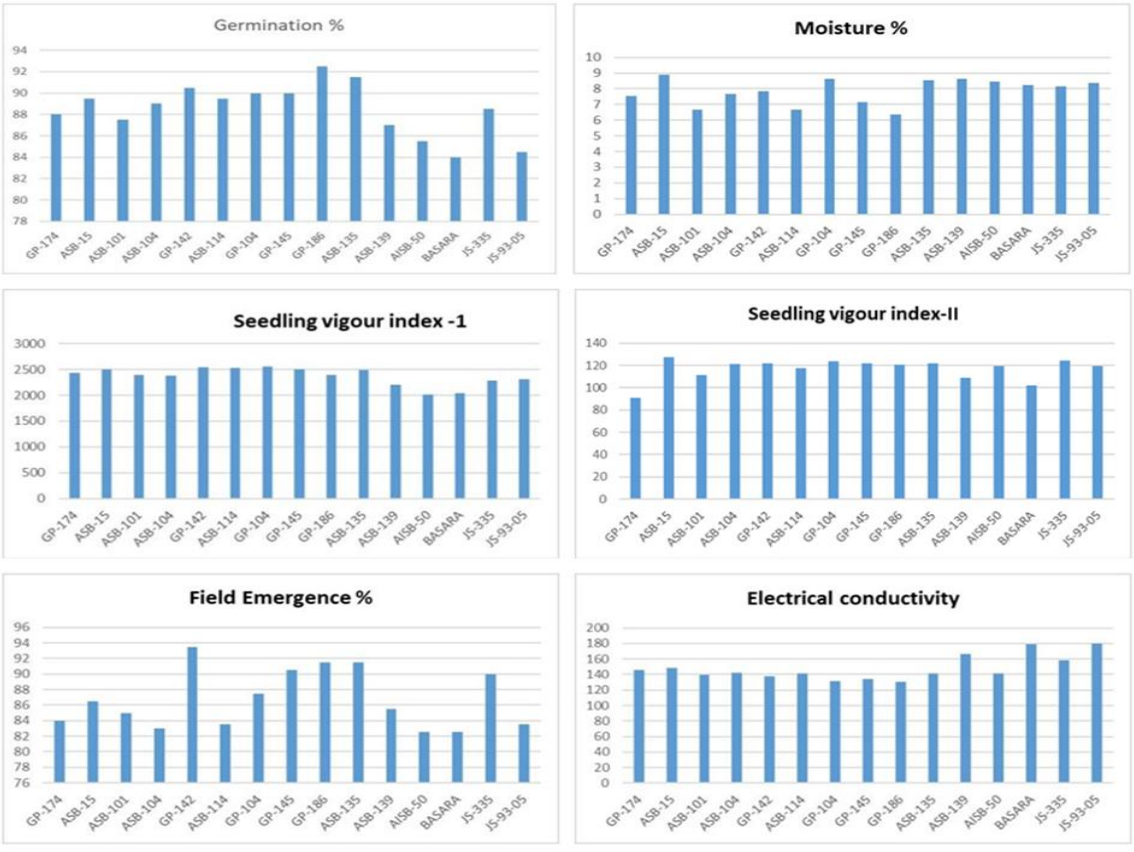

Figure 2. Graphical representation of seed quality traits for the best soybean genotypes

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