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RESEARCH ARTICLE

ASSESSING GE-INTERACTION AND STABILITY PARAMETERS FOR YIELD AND RELATED TRAITS IN SOYBEAN

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ABSTRACT

Thirty-four genotypes of soybean were evaluated under eight diverse environments to know the nature and magnitude of genotype x environment interaction and stability in performance for seed yield and eleven other characters. It was observed that G X E (linear) component was significant for all the characters except days to maturity, number of seeds/pod, harvest index, 100 seed weight and oil content, whereas pooled deviation, a non-linear component, was significant for days to 50% flowering, days to maturity, 100 seed weight, oil content and protein content. The results indicated that both linear and non-linear component of g x e interaction were responsible for the differences in the stability of genotypes observed. Among the 34 genotypes, six genotypes namely PK 416, VLS 47, Pb 1, PS 1042, CO 2 and PK 564 were found to be stable for seed yield and also for biological yield and days to 50% flowering. Further, two genotypes Alankar and PK 471 were found stable under favourable environments having high mean seed yield, b>1 and non-significant deviation from regression.

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INTRODUCTION

The soybean (*Glycine max* (L.) Merrill) is the world's most important oil and grain legume crop. Primary gene centre of soybean origin is north-eastern China. The importance of this crop is primarily due to its chemical grain composition- 40% protein and 20% oil, amounting to more than 60a5 of nutrients. Yield grain, protein and oil content in soybean seed are determinate by genetic and environmental factors (Popovic, 2010; Miladinovic *et al*., 2011). The expression of seed yield and its components are the function of genotype (G), environment (E) and G x E interaction impact. Breeding programmes are intended to develop new varieties with superior agronomic performance compared to those in current production by farmers. Prior to release of the new varieties, they are evaluated in yield trials at several locations in multi-location trials. The variety trials provide important information that enables selection and recommendation of crop cultivars (Yan and Tinker, 2006; Yang *et al*., 2009). Genotype x environment interaction (GEI) is a major concern in plant breeding for two main reasons; first, it reduces progress from selection and second, it makes cultivar recommendation difficult because it is statistically impossible to interpret the main effects. A potential genotype may sometimes fail to reach an optimum phenotypic expression that is well discernible. Thus, the suitability of genotype over time and space depends upon their capacity to minimize the impact of G x E interaction, which is their homeostatic property or buffering efficiency (Sharma, 1994). Further, the number of materials evaluated and the number of test environments required in multi-location trials affects the cost of plant breeding. However reduction in the number of test sites requires a thorough understanding of the genotype and GEI (Bernardo, 2002). A specific genotype does not always exhibit the same phenotypic characteristics under all environments and different genotypes respond differently to a specific environment. The main objective of soybean breeding programme has been to develop varieties that perform well over a broad spectrum of environments. Thus, assessment of the nature and extent of genotype x environment interaction and identification of phenotypic stable genotypes, showing low genotype x environment interaction, becomes important. This requires the screening of promising and stable genotypes in a set of environmental conditions. Various biometrical procedures are now available to measure the stability of genotypes over environment. In soybean breeding, the focus of attention has been on yield increase and stability, that is, developing cultivars that are well adapted to various growing conditions.

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Grain yield and quality are metric traits which are generally quantitatively inherited (polygenic) and are strongly dependent on environmental conditions. Assessing any genotypic performance without including its interaction with the environment is incomplete and limits the accuracy of measured parameter estimates. Studies of the causal factors of the G x E effect and quantifying unexplained variation are of prime importance for selection and recommendation of environmentally stable varieties. Therefore, an attempt has been made to assess the GE-interaction and stability parameters in thirty four genotypes of soybean grown in eight environments.

MATERIALS AND METHODS

The material for the present study comprised of thirty-four genotypes of soybean collected from Department of Genetics and Plant breeding, GBPUA&T, Pantnagar (Uttra Khand). These thirty-four genotypes were grown over eight environments i.e. early and late sowing at two diverse locations (Pantnagar and Simbhaoli) in two years (2008 and 2009) in randomized block design (RBD) with three replication. Each genotype was assigned to a single row plot of 3m length with a distance of 30 cm and 15 cm between plots and plants, respectively. All the recommended cultural practices were adopted to raise a good and healthy crop. The data were recorded on five competitive plants on the following twelve characters viz., days to 50% flowering, days to maturity, plant height (cm), number of pods per plant, number of seeds per pod, biological yield (g), harvest index (%), seed yield efficiency, 100 seed weight (g), seed yield (g), oil content (%) and protein content (%). The mean data of five plants in each replication for each genotype was utilized for the statistical analysis. The stability model proposed by Eberhart and Russell (1966) was followed to estimate the three parameters of stability namely mean, regression coefficient (bi) and mean squared deviation (S^2di) for each genotype.

RESULTS AND DISCUSSION

The pooled analysis of variance for twelve different characters exhibited that there were highly significant differences among the genotypes for all the characters (Table 1) suggesting enough genetic variability among the genotypes for all the characters. The mean squares due to environments were also significant for all the traits indicating the environments selected were random and were different in agro-climatic conditions. The presence of variation between environments point out the presence of dissimilarity and provide a baseline information to categorize potential, low potential and intermediate yielding agro ecologies. The genotype effect depicted clear variation among tested genotypes thus wide and specific adaptation of genotypes is crucial for vertical increase of production. Genotypes, environment and Genotype x environment interaction showed significant differences indicating rank difference in genotypes response at different environments and the need for extension of stability analysis. G x E interaction reduces the association between phenotypic and genotypic values, and thus, genotypes that perform well in one environment may perform poorly in another (Fox *et al*., 1996). Further, the G x E linear component was significant for all the characters except days to maturity, number of seeds per pod, harvest index, 100 seed weight and oil content (%) which indicated that there were differences among regression for the genotypes.

The genotype x environment interaction were significant for most of the characters except number of seeds per pod, biological yield and harvest index in which harvest index was derived character using other principle components indicating that the character responded to the environments differently (Table 1). The importance of G X E interaction in soybean has been recognized by several workers (Smith *et al*., 1967; Baihaki *et al*., 1976; Sediyama and Sakiyama, 1989; Popovic *et al*., 2013; Ishaq *et al*., 2015). Further, the regression analysis partitions the G X E interaction into two components, regression coefficient and deviation from regression. Significant differences among slope on regression coefficients indicate the response of each genotype to a change in the environment, while significant deviation from regression indicate non-linear response i.e. G x E interactions gets unexplained by additive environmental effects. A variety can be considered stable across environments if it has high mean grain yield, unit regression and least deviation around the regression slope (Eberhart and Russell, 1966). Phenotypic stability of the genotypes was measured by three parameters i.e. mean performance over environments ($\overline{X}$), regression coefficient (bi) and deviation from regression (S^2di).

According to Eberhart and Russell's criteria of stability, a stable genotype should have higher mean than population mean, b=1 and S^2d=0, but for days to 50% flowering and days to maturity, the desirable and stable genotype could have low mean, b=1 and S^2d=0. Considering high mean performance and stability parameters together the genotypes PK-416, VLS-47, Pb-1, PS-1042, CO-2 and PK-564 were considered as desirable and stable for seed yield (Table 2). Certain genotypes were also found to be stable for yield related traits i.e. 11 genotypes for days to 50% flowering; 4 genotypes each for days to maturity and number of pods/plant; 7 genotypes each for plant height, biological yield, harvest index and oil content; 8 genotypes each for number of seeds/pod and 100 seed weight; 12 genotypes for seed yield efficiency and 6 genotypes for protein content (Table 2). The performance of eight genotypes was unpredictable due to their significant deviation from regression (Table 3). Further, among the six genotypes stable for seed yield, PK 564 was having highest seed yield (9.29 g) and was also found stable for days to 50% flowering, days to maturity, number of pods/plant and seed yield efficiency. In general, the genotypes identified stable for seed yield also showed stability for one or more component character like days to 50% flowering, biological yield, number of seeds/pod, number of pod/plant, oil content and seed yield efficiency. This indicated that stability of various component traits might be responsible for the observed stability of genotypes for seed yield. Hence, chances of selection of stable genotypes for seed yield could be enhanced by selecting for stability for yield components. It was also earlier observed that stability of seed yield might be due to stability of various yield components (Grafius, 1959).

Table 1. Joint regression analysis for yield and yield components in soybean (Eberhart and Russell, 1966)

Source of variation	d.f.	Mean squares											
		Days to 50% flowering	Days to maturity	Plant height (cm)	No. of pods per plant	No. of seeds per pod	Biological yield (g)	Harvest index (%)	Seed yield efficiency	100 seed weight (g)	Seed yield (g)	Oil content (%)	Protein content (%)
Genotype (G)	33	113.26**	18.06**	396.05**	991.51**	0.122**	132.03**	38.78**	0.018**	19.25**	24.13**	7.11**	7.66**
Environment (E)	7	76.09**	70.76**	1140.16**	912.18**	0.02**	562.98**	33.61**	0.015**	0.91**	78.35**	1.01**	0.66**
G X E	231	6.62**	0.50*	11.98**	13.52**	0.001	7.78	1.21	0.001**	0.04**	1.04*	0.09*	0.09**
E + G X E	238	2.84	2.57	45.16	39.95	0.002	24.11	2.17	0.001	0.06	3.31	0.12	0.11
E (linear)	1	532.18**	496.51**	7981.47**	6385.18**	0.160**	3940.76**	235.12**	0.111**	6.36**	548.49**	7.28**	4.20**
G X E (linear)	33	1.14**	0.64	30.81**	48.81**	0.001	19.00**	0.895	0.001**	0.03	3.33**	0.06	0.11*
Pooled deviation	204	0.52**	0.46**	8.58	7.41	0.001**	5.74	1.22	0.0004	0.04**	0.64	0.09**	0.08**
Pooled error	528	2.25	0.28	8.79	8.95	0.0009	7.90	1.45	0.0005	0.01	0.83	0.06	0.03

*,** = Significant at P = 0.05 and P = 0.01 levels, respectively

Table 2. Stable genotypes and their estimates of stability parameters for different characters in soybean

S.No.	Genotypes	X	bi	S^2di
A.	Days to 50% flowering			
	1. PK 416	49.50	0.95	0.01
	2. PK 327	51.50	0.95	0.01
	3. PK 1029	51.88	0.87	0.26
	4. PK 262	52.29	0.90	-0.17
	5. JS-72-280	51.83	0.99	0.11
	6. Kalitur	53.08	0.84	0.98
	7. Bhatt	51.87	0.85	0.28
	8. Pusa 40	52.00	1.08	0.16
	9. Pusa 1042	52.29	1.11	0.34
	10. Co 2	52.42	0.94	-0.18
	11. PK 564	51.29	0.88	0.59
	Population mean 54.51			
B.	Days to maturity			
	1. PK 471	119.88	0.86	0.11
	2. PK 327	118.50	0.93	0.40
	3. Bragg	119.96	1.15	1.26
	4. PK 564	118.83	0.86	0.15
	Population mean 121.13			
C.	Plant height (cm)			
	1. MACS 450	71.37	1.13	-5.50
	2. PK 327	68.35	1.15	-1.43
	3. JS-72-44	69.57	0.97	-5.80
	4. Improved Pelican	68.71	1.04	-4.74
	5. VLS 47	68.43	1.04	-2.86
	6. Pb 1	74.49	0.89	-2.69
	7. MACS 124	70.70	1.16	-6.56
	Population mean 64.98 cm			
D.	Number of pods/plant			
	1. PK 327	59.48	1.01	5.21
	2. Ankur	54.29	1.01	-7.58
	3. Shilajeet	54.05	1.13	-1.06
	4. PK 564	53.85	0.93	6.22
	Population mean 48.23			

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E.	Number of seeds/pod			
	1. PS 1024	1.97	1.06	0.00
	2. JS 80-21	1.97	0.90	0.00
	3. PK 1029	1.98	1.01	0.00
	4. MACS 754	1.97	1.15	0.00
	5. JS 72-44	1.99	1.14	0.00
	6. Bragg	1.90	1.10	0.00
	7. VLS 47	1.99	0.97	0.00
	8. PS 1042	2.00	0.93	0.00
	Population mean 1.86			
F.	Biological yield (g)			
	1. PK 416	25.65	0.93	2.51
	2. PK 564	26.97	0.97	4.14
	3. Pb 1	24.13	1.22	-5.37
	4. Co 2	24.99	0.82	-5.92
	5. PK 1029	27.11	1.11	-4.98
	6. PS 1042	26.49	0.89	-5.80
	7. Shilajeet	25.02	1.07	-3.81
	Population mean 22.93 g			
G.	Harvest index (%)			
	1. Himso 1563	33.98	1.10	-1.02
	2. PS 1024	34.73	1.13	-1.01
	3. PK 471	35.30	1.19	1.58
	4. Bhatt	33.64	1.12	-1.17
	5. Pusa 40	36.38	0.99	-0.26
	6. PS 1042	34.08	1.18	-1.05
	7. Shilajeet	34.79	1.14	-0.32
	Population mean 32.79%			
H.	Seed yield efficiency			
	1. Himso 1563	0.51	1.21	0.00
	2. PK 471	0.55	1.17	0.00
	3. JS 80-21	0.50	0.94	0.00
	4. PK 327	0.52	1.16	0.00
	5. JS 335	0.50	1.15	0.00
	6. Bragg	0.52	0.94	0.00
	8. Bhatt	0.51	1.13	0.00
	9. Pb 1	0.50	1.02	0.00
	10.Pusa 40	0.57	1.11	0.00
	11.Shilajeet	0.53	1.14	0.00
	12.PK 564	0.52	1.17	0.00
	Population mean 0.49			
I.	100 seed weight (g)			
	1. Himso 1563	10.71	1.16	0.03
	2. MACS 450	11.25	1.15	0.00
	3. PS 1024	11.98	0.98	0.00
	4. PK 1029	13.14	1.03	0.02
	5. Bragg	11.17	1.14	0.02
	6. PK 472	11.17	0.94	0.01
	7. PK 262	13.18	0.98	0.00
	8. PS 1042	12.16	1.15	0.04
	Population mean 10.54 g			
J.	Seed yield (g)			
	1. PK 416	8.58	0.98	0.30
	2. VLS 47	8.96	1.14	0.44
	3. Pb 1	8.09	1.24	-0.50
	4. PS 1042	9.02	0.98	0.55
	5. Co 2	8.51	0.94	-0.66
	6. PK 564	9.29	1.13	0.43
	Population mean 7.59 g			
K.	Oil content (%)			
	1. PK 416	21.46	0.95	0.03
	2. PS 1024	21.10	0.98	-0.02
	3. Lee	21.27	0.88	0.06
	4. PK 472	22.24	1.05	-0.06
	5. Ankur	21.37	1.18	0.01
	6. Pusa 40	21.32	0.92	0.04
	7. PS 1042	21.17	1.20	-0.04
	Population mean 20.37			
L.	Protein content (%)			
	1. PS 1024	39.99	0.91	0.18
	2. T 49	40.48	1.13	0.09
	3. JS 335	40.48	1.00	0.22
	4. Bragg	40.37	0.96	0.12
	5. JS 72-280	41.42	1.12	0.02
	6. Shilajeet	40.61	0.92	0.05
	Population mean 39.39 %			

Table 3. List of stable genotypes for seed yield and related traits in 34 genotypes of soybean

S.No.	Genotypes	Seed yield (g)			Other traits showing stability					
		X	b	S^2d					b	S^2d
1.	Himso 1563	7.05	1.28	-0.55	HI, SYE,	SW,DM$^{\#\#}$			1.28	-0.55
2.	Pusa 16	5.60	0.24**	0.18					0.24**	0.18
3.	MACS 450	7.63	1.33	-0.56^{+}	PHT, SW				1.33	-0.56^{+}
4.	PK 416	8.58	0.98	0.30	DF, BY,	OC, S/P$^{\#}$,	SW$^{\#}$, HI$^{\#\#}$,	SYE$^{\#\#}$	0.88	0.30
5.	PS 1024	7.44	0.98	-0.64	S/P, HI,	SW, OC,	PC, P/P$^{\#}$		0.98	-0.64
6.	Indira Soya 9	5.22	0.55*	0.46					0.55*	0.46
7.	Alankar	10.96	1.86*	0.14	BY$^{\#}$,	SYE$^{\#}$,SW$^{\#}$,	S/P$^{\#\#}$,	DM$^{\#\#}$	1.86*	0.14
8.	PK 471	11.24	2.01**	1.69	DM, HI,	SYE,P/P$^{\#}$,	OC$^{\#}$,	SW$^{\#\#}$	2.01**	1.69
9.	JS 80-21	7.05	0.96	0.70	S/P, SYE,	PHT$^{\#}$,			0.96	0.70
10.	PK 327	8.13	0.71	1.46^{+}	DF, DM,	PHT, P/P,	SYE, HI$^{\#}$		0.71	1.46^{+}
11.	PK 1029	9.51	1.36	-0.52^{++}	DF, S/P,	BY, SW,	HI^{+},SYE$^{\#}$		1.36	-0.52^{++}
12.	MACS 754	4.71	0.31**	0.44	S/P, PC$^{\#}$				0.31**	0.44
13.	MAUS 32	6.39	0.99	-0.42					0.99	-0.42
14.	Lee	5.08	0.66*	-0.67	OC, PHT$^{\#}$				0.66*	-0.67
15.	T 49	7.38	1.19	-0.43	PC, PHT$^{\#}$				1.19	-0.43
16.	JS 72-44	5.14	0.60*	0.56	PHT, S/P,				0.60*	0.56
17.	Improved Pelican	6.97	1.06	-0.58	PHT, S/P$^{\#}$				1.06	-0.58
18.	JS 335	7.68	1.03	0.36	SYE, PC				1.03	0.36
19.	Bragg	6.06	0.50**	-0.26	DM, S/P,	SYE, SW,	PC,DF$^{\#\#}$,	HI$^{\#\#}$	0.50**	-0.26
20.	PK 472	9.93	2.01*	0.60^{++}	SW, OC,	HI$^{\#\#}$,	SYE$^{\#\#}$		2.01*	0.60^{++}
21.	NRC 57	5.13	0.40*	-0.40	S/P$^{\#\#}$				0.40*	-0.40
22.	PK 262	7.47	0.86	0.58	DF, SW,	SYE$^{\#}$,	S/P$^{\#\#}$		0.86	0.58
23.	Ankur	8.55	1.31	-0.06^{+}	P/P, SYE,	OC, BY$^{\#}$,	PHT$^{\#\#}$		1.31	-0.06^{+}
24.	VLS 47	8.96	1.14	0.44	PHT, S/P,	HI+,SYE$^{\#}$,	DF$^{\#\#,}$	SW$^{\#\#}$	1.40	0.44
25.	JS 72-280	5.11	0.50*	-0.65^{+}	DF, PC				0.50*	-0.65^{+}
26.	Kalitur	6.23	0.66*	0.55	DF, PC$^{\#}$,	S/P$^{\#\#}$			0.66*	0.55
27.	Bhatt	7.27	0.78	-0.50	DF, HI,	SYE,			0.78	-0.50
28.	Pb 1	8.09	1.24	-0.50	PHT, BY,	SYE,	DM$^{\#\#}$		1.24	-0.50
29.	Pusa 40	10.39	1.66*	-0.55^{++}	DF, HI,	SYE, OC,			1.66*	-0.55^{++}
30.	PS 1042	9.02	0.98	0.55	DF, S/P,	BY, HI, SW,	OC, SYE$^{\#}$,	PHT$^{\#\#}$	0.88	0.55
31.	CO 2	8.51	0.94	-0.66	DF, BY,	DM$^{\#\#}$, HI$^{\#\#}$	S/P$^{\#\#}$,	SYE$^{\#\#}$	0.94	-0.66
32.	MACS 124	6.73	0.56**	1.20^{+}	PHT,				0.56**	1.20^{+}
33.	Shilajeet	8.71	1.17	-0.27	P/P, BY,	HI, SYE,	PC, S/P$^{\#}$,		1.17	-0.27
34.	PK 564	9.29	1.13	0.43	DF, DM,	P/P, SYE,			1.13	0.43
	Mean	7.59								

*,** = Significantly deviating from unity at P = 0.05 at P = 0.01 level, respectively.
+,++ = Significantly deviating from zero at P = 0.05 and P = 0.01 level, respectively.
#,## = Stable for favourable and unfavourable environments, respectively. DF=Days to 50% flowering, DM=Days to maturity, PHT=Plant height, P/P=Number of pods/plant, S/P=Number of seeds/pod, BY=Biological yield, HI=Harvest index, SYE=Seed yield efficiency, SW=seed weight, OC=Oil content, PC=Protein content.

Two genotypes, Alankar and PK 471 had high seed yield with high responsiveness (b>1) and non-significant deviation from regression depicted below average stability suggesting that these genotypes were more sensitive to changing environments and therefore, showed suitability for high yielding environments. Similar results were also reported by earlier workers (Taware *et al*., 1994; Deka and Talukdar, 1997; Raut *et al*., 1997; Schoffel *et al*., 2003; Rammna and Satyanarayana, 2005; Popovic *et al*., 2013; Ishaq *et al*., 2015). Thus, it was evident that stability parameters varied from genotype to genotype for various traits. Not a single genotype showed average stability for all the characters studied. It may be concluded that PK 416, VLS 47, Pb 1, PS 1042, CO 2, and PK 564 had consistent performance for seed yield across the environments. Hence, these genotypes would be quite useful for sustainable production of soybean.

REFERENCES

Baihaki A., Stucker R.E. and Lambert J.W. 1976. Association of genotype x environment interactions with performance level of soybean lines in preliminary yield tests. *Crop Sci.,* 16: 718-721.

Deka S.D. and Talukdar P. 1997. Stability behaviour of some soybean [Glycine max (L.) Merrill] genotypes under environmental variability. *Indian J. Genet., 57*: 36-39.

Eberhart S.A. and Russell W.A. 1966. Stability parameters for comparing varieties. *Crop Sci.,* 6: 36-40.

Fox, P.N., Skovmand, B., Thomson, B.K., Braun, H.J. and Comier, R. 1990. Yield and adaptation of hexaploid spring triticale. Euphytica 47: 57-64.

Grafius J.E. 1959. Heterosis in barley. Agron. J. 51: 551-554.

Ishaq, M.N., Agrama, H. and adeleke, A. 2015. Exploiting genotype x environment interaction in soybean breeding in Nigeria. *Int. J. Adv. Res. Biol. Sci.* 2: 24-32.

Popovic,V., Miladinovic, J., Tatic, M., Djekic, V., Dozet, G., Dukic, V. and Grahovac, N. 2013. Stability of soybean yield and quality components. *African J. Agric. Res*. 8: 5651-5658.

Rammana M.V. and Satyanarayana A. 2005. Stability analysis for yield and component traits in soybean [*Glycine max* (L.) Merrill*]. J. Oilseeds Res.,* 22: 18-21.

Raut V.M., Taware S.P., Halvankar G.B. and Patil V.M. 1997. Stability analysis for oil and yield in soybean. Soybean Genetics Newsletter 24: 92-95.

Schoffel E.R., Valpe C.A., Athayde M.L.F. and Pavani L.C. 2003. Stability of yield components of soybean cultivarsin sowing date and irrigation. *Cientifica Jaboticabal* 31: 167-178.

Sediyama C.S. and Sakiyama N.S. 1989. Study of phenotypic stability of nine soybean [*Glycine max* (L.) Merrill] lines by stepwise linear regression analysis. Revista Ceres., 36: 217-225.

Sharma J.R. 1994. *Principle and Practice of Plant Breeding.* Tata McGraw-Hill Company, New Delhi.

Smith R.R., Byth O.E., Caldwell B.E. and Wber C.R. 1967. Phenotypic stability in soybean population. *Crop Sci*., 7: 590-592.

Taware S.P., Halvankar G.B. and Patil V.M. 1994. Phenotypic stability analysis of soybean varieties in kharif and summer seasons. *J. Oilseeds Res.,* 11: 237-241.

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