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Analysis of stability for some characters in soybean [*Glycine max* (L.) Merrill]

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ABSTRACT
The phenotypic stability of 8 genotypes of soybean grown over three different environments (years) was studied for seed yield and various other component characters . Highly significant differences were observed among the environments for grain yield and days to maturity. Highly significant environment (linear) effects were observed for grain yield, number of branches per plant and days to maturity. The genotype x environment (linear) mean squares were highly significant for grain yield and days to maturity . The genotype LSb 3 was found to be stable for seed yield per plant, and all other component characters. The yield performance of the genotypes LSb 1, PK 1029, MACS 450 and JS 335 was found satisfactory, though yield level varied over the environments. Stable genotypes for other characters and suitable genotypes for different seasons were also identified.

Key words : Environment, Genotype , *Glycine max* L. Interaction, Stability.

INTRODUCTION
Soybean [*Glycine max* (L) Morrill] is an important oil seed crop of India. Andhra pradesh is one of the major soybean cultivating states with an area of about 89 thousand hectares and the production of about 6 lakh tonnes. Intrinsic feature of photo-insensitiveness makes its cultivation possible throughout the year . Soybean with its rich nutritional value (40% protein and 20% edible oil) has a coveted place among the pulse crops being cultivated all over the world. In realization of its utility, intensive research and development programmes have been undertaken in this crop. During last one and a half decade, the growth in area, production and productivity has been 752% , 1550% and 91% respectively. However, low productivity level in A.P. is mainly due to significant genotype x season interaction. But only a few studies have been made in this direction to identify suitable genotypes for different environments. Therefore, data on grain yield and its components obtained on 8 varieties of soybean over three environments and was subjected to stability analysis, to obtain information on genotype x environment interaction.

MATERIALS AND METHODS
The material for the present study comprised 8 genotypes viz., MACS 450, PK 1029, PK 472, LSb 1, LSb 3, JS (SH) 93-37, NRC-51 and JS 335 of soybean cultivated in different parts of the India. The experiment was conducted in a randomized block design with three replications in each season. Each entry was grown in 6 rows of 4 m length with row to row and plant to plant spacing of 30 x 10cm respectively. All the recommended package of practices were followed for raising a normal and healthy crop in all the seasons. The observations were recorded on days to 50% flowering, days to maturity, plant height(cm), number of branches per plant, number pod of per plant, 100 seed weight and seed yield per plant on five randomly selected plants from each genotype in each replication. Stability analysis was carried out as per the procedure given by Eberhart and Russell (1966).

RESULTS AND DISCUSSION
The highly significant mean squares due to varieties revealed the presence of genetic variability in the material (Table-1). The differences amongst the environments were also highly significant for grain yield and days to maturity. The environment (linear) were highly significant for grain yield, number of branches per plant and days to maturity. The genotype x environment (linear) mean squares were highly significant for days to maturity and grain yield. The linear component of environment and pooled deviation assumed importance for grain yield, which indicated the contribution of both linear and non-linear components of variance towards GXE interaction in respect of grain yield. This is in agreement with the findings of Chauhan (1984) and Acharya et al (1985).

The values of environmental indices (Table 2) were negative for days to 50% flowering ($E_2$and E_3) , for days to maturity (E_1), for plant height (E_1 and E_2) , for branches per plant (E_1 and E_2), for pods per plant (E_3), for 100 seed weight (E_1) and for grain yield (E_1 and E_2) indicating that these environments were poor for the manifestation of these traits.

Stability parameters were estimated for all the characters as per Eberhart and Russell model (1966) and are presented in Table 3. According to the model, the ideal genotype would be the one which had high mean, regression coefficient equal to unity (bi=1) and low mean square deviation (S^2di=0). Further , the genotypes exhibiting high regression coefficient (bi>1) could be considered as below average stable varieties and such varieties would perform well only in favourable environments, while their performance would be poor in unfavourable environments. The varieties with low regression coefficient (bi<1) were above average stable and were adopted specifically to poor environments.

In the present study most of the varieties expressed stability for one to five characters, but the genotype LSb 3 was found to be stable for seed yield and all other component characters. Hence, the genotype LSb 3 can be grown in all the seasons with predictable seed yield. Stable genotypes for seed yield per plant were also reported by Gopani et al (1972) and Konwar and Talukdar (1986). JS 335, the ruling variety in the state, and black seeded variety JS (SH) 93-37, MACS 450, PK 472 and NRC 51 exhibited highest and satisfartory seed yield in all the environments, though yield levels varied over the seasons. The bi values were negative for days to 50% flowering, number of branches per plant, pods per plant and 100 seed weight, which could be attributed to the inadequency of the scale used for the analysis and for the inherent behaviour of the genotypes investigated. Similar observation were made by Korla and Singh (1988) and Gautam and Chaturvedi (1990) in pea's . The prediction of GXE interaction depends on relative magnitude of the linear and non-linear components and under the present situation the linear regression being predominant, assumed considerable practical significant.

For the characters, days to 50% flowing and maturity, MACS 450, LSb 3 gave high mean performance, with near unity bi values and low S^2di values. For the characters branches per plant, and seed yield LSb 3 performed well across the environments with high mean, unit regression and least S^2di, while other genotypes were characterized as unstable genotypes.

CONCLUSIONS
With considering the above discussion, it is concluded that the genotypes exhibiting average stability for seed yield and yield

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Table 1: ANOVA for stability analysis for 7 characters in soybean

Source	df	Days to 50% flowering	Days to maturity	Plant height (cm)	Branches per plant	Pods per plant	100 seed weight (gm)	Grain yield kg/ha
Varieties	7	33.22***	284.9***	85.7***	0.4**	104***	0.95*	106707**
Environment	2	0.42	4.28***	1.06	0.15	1.19	0.27	580267***
Var x eru	14	0.52	0.82**	0.97	0.05	2.85	0.26	12542**
Emv +(Var x Env)	16	0.51	1.26**	0.98	0.06	2.64	0.26	83508**
Env (linear)	1	0.84	8.56***	2.12	0.30**	2.37	0.53	1160533***
Var x env (lin)	7	0.39	1.53***	0.39	0.05	4.02	0.20	6926**
Pooled deviations	8	0.57	0.10	1.35**	0.04**	1.47**	0.27	15888***
Pooled error	42	0.27	0.46	0.41	0.01	0.48	0.13	529

***, **, * Significant at 0.1%, 1% and 5% level respectively

Table 2 : Values of environmental indices for 7 traits in soybean

Environment	Days to 50% flowering	Days to maturity	Plant height (cm)	Branches per plant	Pods per plant	100 seed weight (gm)	Grain yield kg/ha
E_1 (kharif 2000-01)	0.264	-0764	-0.097	-0.124	0.222	-0.204	-224.9
E_2 (Kharif 2001-02)	-0.111	0.069	-0.306	-0.024	0.222	0.146	-73.6
E_3 (kharif 2002-03)	-0.153	0.694	0.403	0.147	-0.444	0.058	298.5

Table 3 : Mean and stability performance of the characters in soybean

S. No	Genotypes	Day to 50%flowering			Day to maturity			Plant height		
		x	b_1	s^2di	x	bi	s^2di	x	bi	s^2di
1	MACS 450	41.78	0.07	-0.07	93.00	1.36	-0.45	21.56	2.38	3.91*
2	PK 1029	40.44	-1.54	-0.05	102.67	-0.65	-0.25	32.78	1.03	0.24
3	PK 472	42.33	-1.06	0.23	101.67	2.46	-0.08	31.89	-1.29	1.19
4	LSb 1	32.67	4.61	2.11*	76.00	1.36	-0.45	19.11	1.03	0.24
5	LSb3	36.67	1.19	-0.24	85.11	0.22	-0.44	26.33	0.52	0.37
6	JS (SH) 93-37	37.56	1.93	0.48	83.89	0.24	-0.45	30.89	1.38	0.46
7	NRC 51	39.89	0.35	-0.25	95.89	0.24	-0.45	25.78	0.40	0.92
8	JS 335	41.89	1.80	-0.14	100.56	2.77	-0.37	33.11	2.55	-0.09
		39.15			92.35			27.69		

S. No.	Genotypes	Branches per plant			100 Seed Weight (gm)			Pods per plant			Grain yield (kg/ha)		
		x	b_1	s^2di	x	bi	s^2 di	x	bi	s^2di	x	bi	s^2 di
1	MACS 450	2.20	1.44	-0.01	11.80	-2.15	0.38	21.22	0.50	0.41	1104	1026	19271**
2	PK 1029	2.49	0.59	-0.01	11.44	0.51	0.01	20.89	8.75	0.91	819	0.94	9538***
3	PK 472	2.16	0.89	-0.01	12.00	0.66	-0.10	18.11	0.25	0.91	1043	1.12	19012**
4	LSb 1	2.62	0.16	0.26*	11.96	3.31	0.49*	19.67	3.75	4.02**	970	0.52	27696**
5	LSb 3	2.73	-0.06	0.00	11.67	2.15	0.01	29.89	0.50*	-0.48	1288	0.91	-363
6	JS(SH)93-37	2.43	-0.06	0.00	11.27	-0.40	0.44*	29.44	-1025	2.25*	1286	1.20	4719**
7	NRC 51	2.17	1.77	0.00	11.43	1.32	0.00	22.89	-2.50	0.41	1129	0.87	37704**
8	JS 335	3.19	3.26	0.04	13.07	2.59	-0.11	34.44	-2.00*	-0.48	1393	1.11	5547**
		2.50			11.83			24.57			1129		

***, **, * Significant at 0.1%, 1% and 5% level respectively components can be used in a breeding programme for crossing with an unstable but otherwise possessing high mean performance. Thus, the genotypes LSb 3 JS 335, PK 1029 and MACS 450 are recommended for inclusion in future breeding programme of soybean for improving the yield potentiality.

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