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Stability Analysis for Grain Yield and its Components in Soybean (*Glycine max* L. Merrill)

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Abstract

The present investigation was conducted with twenty two genotypes including five checks of soybean (*Glycine max* L.) for stability performance over three environments in a R.B.D. with three replication during *kharif*-2016. The analysis of variance revealed significant differences among the genotypes for all traits studied over all environments, indicating sufficient amount of variability present. G X E interaction is highly significant for all character studied except plant height, number of pods per plant and oil content. Environment (linear) was highly significant for all traits except number of seeds per pod and oil content. The predominance of linear component would help in predicting the performance of genotypes across environment. Considering the nature of stability, two genotypes MAUS-740, MAUS-710 were found promising and they had stable performance over three environments for grain yield per plant^{-1} while MAUS-614 was suitable for favorable environment. For number of branches plant^{-1} two genotypes, KDS-980 and MACS-1460 showed superiority for average response and stability under all environments. For number of pod per plant three genotypes, KDS-1045, AMS-100-39-1 and MAUS-706 had stable performance in all three environments. For number of seeds pod^{-1} genotypes, AMS-1002, AMS-1003, MAUS-706 and MAUS-158 suitable under unfavorable environment.The genotypes, MAUS-740, MAUS-614 had stable performance over three environments for 100 seed weight. Use of genotype with wide (MAUS-740, MAUS-710) or specific stability (KDS-921, MACS-1543, AMS-MB-5-19, KDS-1045, AMS-100-39-1, MACS-1460, JS-93-05, MAUS-706)) in development of new varieties with desired nature of adaptability suggested.

Keywords: Stability analysis, soybean genotypes, yield plant^{-1}

1. Introduction

Soybean (*Glycine max* (L.) Merill) is also known as 'golden bean' and miracle crop which is an efficient producer of two most scarce items in the world food economy i.e. high quality protein (40%) and oil (20%). In India, the area under soybean during *kharif*- 2015-16 was 109.71 lakh ha with total production of 114.90 lakh MT with an average productivity of 1047 kg ha^{-1}. India ranks fifth in area and production of soybean in the world after USA, Brazil, China and Argentina. Major soybean growing states in India are Madhya Pradesh, Maharashtra, Rajasthan, Andhra Pradesh and Karnataka etc. Madhya Pradesh ranking 1st in production of soybean. Soybean was introduced in Maharashtra state during the year 1984-85 and it was grown only on 5.6 lakh ha until 1994 but now a day's area under soybean is increasing largely. In Maharashtra area under soybean during *kharif* – 2016 was 35.80 lakh ha with total production 39.45 lakh MT with an average productivity of 1102 kg ha^{-1}. For advancement or breakthrough in production in any agricultural crop, the prime requirement is the availability of appropriate genotype. In order to identify superior genotypes that can give reproducible performance (Stable) breeders evaluate the breeding materials over a number of locations or seasons or both. The differential response of genotypes with the varying environments i.e. genotypes environment (GE) interaction, creates the problem in the selection of ideal genotypes over a wide range of environments. A genotype with smallest s2gl is regarded as most stable genotype. Statistical approach of Finely and Wilkinson (1963) proved considerably useful to measure the phenotypic stability in the performance of genotype. He considered the linear regression sole (bi) as measure of stability. This regression analysis proposed by Finely and Wilkinson (1963) was improved by Eberhart and Russel (1966) by introduction of one more parameter, (S^2di) which accounts for unpredictable irregularities in response of genotypes to varying environments. Later on Paroda and Hays (1971) stressed that linear regression of variety be considered for evaluating the potential, whereas deviation around regression gives a measure of stability of genotype over environments. Considering all the above points, present investigation was undertaken in soybean with an object to estimate stability parameters for grain yield and its important components.

2. Materials and Methods

The experimental materials comprised of 17 promising newly developed genotypes of soybean developed at different centres of Maharashtra and five checks *viz*., JS 335, JS 93-05, JS-97-52, MAUS 71, and MAUS 158 were used. These genotypes were sown on three different sowing dates during *kharif* 2016, which created three environments as E1 (Latur), E2 (Parbhani), E3 (Badnapur), respectively. The experiment was laid in randomized block design with three replications maintaining 45x5 cm^2 spacing between rows and plants, respectively. Observations were recorded on 11 characters *viz*., number of days to 50% flowering, days to maturity, plant height, number of branches per plant, number of pods per plants, seeds pods^{-1}, 100 seed weight, seed yield plot^{-1}, oil content, protein content (%),and seed yield per plant. Stability analysis was done as per the procedure suggested by Eberhart and Russel (1966).

3. Results and Discussion

The analysis of variance representing the mean sum of square due to different sources of variation as per Eberthart and Russel (1966) stability analysis is presented in Table 1. Pooled analysis of variance over three different environments showed genotypic variances, when tested against pooled error were highly significant for all traits and when tested against pooled deviation it is highly significant for all traits except grain yield per plot. The difference due to genotypes and environments indicates presence of variation among genotypes as well as among environments. While for environment variance it shows highly significant for traits *viz*. days to 50% flowering, days to maturity, plant height, number of pods plant^{-1}, 100 seed weight, yield plant^{-1} and yield plot^{-1} when tested against pooled error but when tested against pooled deviation it showed significant for days to maturity, plant height, number of pods plant^{-1}, 100 seed weight, yield plant^{-1} and yield plot^{-1}. For G×E interaction, when tested against pooled error it showed significant for all data except plant height, number of pods plant^{-1}, and protein content but when tested against pooled deviation it shows significant for traits *viz*. days to maturity, plant height, number of pods plant^{-1}, 100 seed weight and yield plant^{-1}. Mean square due to pooled deviation was found significant for traits *viz*. days to 50% flowering, days to maturity, 100 seed weight, yield plant^{-1} and yield plot^{-1} when tested against pooler error.

Table 1: Analysis of variance for stability with three environments

Sr. No.	Character	Genotype	Environment	G X E	Env +(G×E)	Env (L)	G×E (L)	PD	PE
	DF	21	2	42	44	1	21	22	126
1.	Days to 50% flowering	12.98^{**++}	2.07^{**}	1.26^{**}	1.30^{**}	4.14^{**}	0.87^{**}	1.57^{**++}	0.10
2.	Days to maturity	50.53^{**++}	23.16^{**++}	2.30^{**++}	3.27^{**++}	46.33^{**++}	3.78^{**++}	0.83^{**++}	0.06
3.	Plant height	168.3^{**++}	191.87^{**++}	5.30^{+}	13.78^{**++}	383.74^{**++}	7.73^{++}	2.74	6.16
4.	No. of branches plant^{-1}	0.14^{**++}	0.021	0.015^{**}	0.015^{**}	0.041^{*}	0.019^{**}	0.011	0.007
5.	No. of pod plant^{-1}	81.27^{**++}	71.36^{**++}	2.68^{++}	5.80^{++}	142.72^{**++}	4.87^{++}	0.47	5.69
6.	No. of seeds pod^{-1}	0.078^{**++}	0.005	0.012^{**}	0.011^{*}	0.010	0.014^{**}	0.009	0.006
7.	100 seed weight	3.36^{**++}	24.35^{**++}	0.21^{**+}	1.30^{**++}	48.71^{**++}	0.325^{**++}	0.09^{*+}	0.05
8.	Grain yield plant^{-1}	23.99^{**++}	98.96^{**++}	1.06^{*++}	5.50^{**++}	197.91^{**++}	1.83^{**++}	0.27^{**}	0.69
9.	Grain yield plot^{-1}	0.033^{**}	1.108^{**++}	0.031^{**}	0.080^{**++}	2.21^{**++}	037^{**}	0.023^{**++}	0.010
10.	Oil content	0.698^{**++}	0.054	0.023	0.025	0.107^{+}	0.027	0.019	0.035
11.	Protein content	6.54^{**++}	0.033	0.090^{**}	0.087^{**}	0.066^{*}	0.077^{**}	0.098^{++}	0.014

PD: Pooled deviation; PE: Pooled error; * and ** indicates significant at (p=0.05) and (p=0.01), against pooled error respectively; + and ++ indicates significant at (p=0.05) and (p=0.01), against pooled deviation respectively

Table 2: Estimates of environmental indices for each character under different environment

Observations	Environments		
	E_1 (Latur)	E_2 (Parbhani)	E_3 (Badnapur)
Days to 50% flowering	-0.348	0.121	0.227
Days to maturity	-0.975	1.071	-0..96
Plant height (cm)	3.236	-2.548	-0.688
No. of branches plant^{-1}	-0.019	0.035	-0.016
No. of pods plant^{-1}	2.032	-1.398	-0.634
Number of seeds pod^{-1}	0.002	0.014	-0.016
100 seed weight (g)	1.174	0.857	-0.317
Grain yield plant^{-1} (g)	2.410	-1.580	-0.830
Grain yield plot^{-1} (kg)	0.014	0.217	-0.231
Oil content (%)	-0.019	0.056	-0.038
Protein content (%)	0.023	-0.046	0.023

Environment indices for 11 characters given in Table 2 showed that that E_1 environment was favourable for characters like plant height, number of pods per plant, 100 seed weight, grain yield per plant and protein content. In E_2 environment was favourable for characters like days to maturity, number of branches, seed per pod, grain yield per plot and oil content. While E_3 environment was favourable for days to 50% flowering and protein content.

4. Stability Parameters of Genotypes

On the basis of results of stability parameters (Table 3), the nature of stability of 22 genotypes for different characters has been discussed below.

Table 3 : Stability parameters (Eberhart and Russell, 1966) for eleven characters in soybean

Sl. No.	Variety	Days to 50% flowering			Days to maturity			Plant height		
		$\bar{X}$	bi	S^2d_i	$\bar{X}$	bi	S^2d_i	$\bar{X}$	bi	S^2d_i
1.	MACS-1460	39.33	-0.186	0.111	95.00	1.849	0.958**	51.33	1.977	-4.456
2.	KDS-904	43.56	0.245	0.847**	97.89	1.032	0.879**	49.60	2.317	-4.759
3.	MAUS-740	40.56	0.810	0.068	95.67	1.017	0.426**	45.87	1.589*	-6.101
4.	AMS-1002	44.22	-0.696	10.767**	99.44	0.354	0.192*	54.09	1.487	-4.739
5.	KS-133	47.56	3.311	0.132	102.11	5.950	2.135**	73.84	1.411	-5.422
6.	MACS-1543	42.22	0.702	4.766**	100.67	-0.554	1.291**	54.69	1.043	7.088
7.	KD-921	47.33	6.216	1.306**	109.89	1.126	0.009	69.65	0.374	-5.778
8.	MAUS-614	41.56	0.810	0.068	95.56	1.495	0.193*	56.20	1.483	-5.501
9.	AMS-1003	42.00	0.568	1.835**	95.33	0.557	2.841**	49.82	0.374*	-6.084
10.	MACS-1505	41.22	1.832	0.228	91.00	0.278	0.663**	53.60	1.405	-6.058
11.	AMS-100-39-1	41.33	4.279	1.123**	92.22	0.572	1.990**	55.49	0.696	-4.357
12.	MACS-1520	42.11	0.218	-0.039	97.00	0.971	-0.049	47.60	0.351	-4.458
13.	KDS-980	44.11	-0.051	1.969**	101.22	0.663	-0.024	53.16	1.252	10.868
14.	MAUS-706	41.00	0.003*	-0.104	98.89	1.356	0.806**	42.02	0.815	-5.088
15.	AMS-MB-5-19	43.11	1.052	0.206	99.78	0.263	1.199**	53.60	0.720	5.337
16.	KDS-1045	40.11	0.514	7.920**	97.78	-0.756	1.029**	54.96	1.348	-5.591
17.	MAUS-710	41.33	1.213	0.285	95.44	1.234	1.469**	45.00	1.100	-5.970
18.	JS-335(C)	40.33	1.213	0.286	94.22	0.524	0.323*	45.27	0.463	-5.294
19.	JS-93-05(C)	40.89	1.455	0.016	91.89	1.126	0.009	47.13	0.739	-0.797
20.	JS-97-52(C)	43.11	2.450	0.175	97.67	2.636	0.195*	53.71	-0.828	-5.290
21.	MAUS-71(C)	42.00	-5.564	0.081	94.33	0.509	0.059	53.33	1.221	-5.899
22.	MAUS-158(C)	42.00	1.670	0.260	97.44	-0.200	0.372**	45.04	0.665	-5.513
	Grand mean	42.31			97.29			52.50		
	SEm±	0.89			0.64			1.171		
	SEb±	2.89			0.62			0.39		

Table 3 : Continue..

Sl. No.	Variety	No. of branches $plant^{-1}$			Number of pods $plant^{-1}$			Seeds pod^{-1}		
		$\bar{X}$	bi	S^2d_i	$\bar{X}$	bi	S^2d_i	$\bar{X}$	bi	S^2d_i
1.	MACS-1460	3.02	-0.789	0.012	48.64	1.514	-5.356	2.89	-4.917	0.003
2.	KDS-904	2.96	-0.789	0.012	38.33	0.787	-5.411	2.93	8.688	-0.005
3.	MAUS-740	3.00	2.041	0.011	46.82	1.360	-5.464	3.02	-2.312	-0.005
4.	AMS-1002	2.78	0.680	-0.005	39.53	-0.533	-4.814	2.93	0.004*	-0.006
5.	KS-133	2.67	-5.805	0.009	49.09	2.469	-5.184	2.60	14.767	0.007
6.	MACS-1543	2.82	1.576	0.071**	45.85	1.620	-5.394	3.02	2.899	0.010

Continue...

Sl. No.	Variety	No. of branches plant^{-1}			Number of pods plant^{-1}			Seeds pod^{-1}		
		$\bar{X}$	bi	S^2d_i	$\bar{X}$	bi	S^2d_i	$\bar{X}$	bi	S^2d_i
7.	KD-921	2.18	4.442	-0.005	39.80	-0.517	-3.454	2.40	3.477	0.023*
8.	MAUS-614	3.04	0.680	-0.005	51.29	1.357	-5.138	3.16	6.373	-0.004
9.	AMS-1003	2.82	1.146	0.002	42.04	-0.377	-5.058	2.98	0.583	0.005
10.	MACS-1505	3.07	1.934	-0.005	44.58	0.371	-4.982	2.96	-4.917	0.003
11.	AMS-100-39-1	2.93	2.041	0.011	49.20	0.858	-5.451	2.98	2.320	-0.005
12.	MACS-1520	2.89	5.123	-0.003	42.18	-0.197	-4.742	2.98	-3.759	0.007
13.	KDS-980	2.91	-1.255*	-0.007	44.47	1.151	-5.439	2.98	4.057	-0.002
14.	MAUS-706	2.67	-1.936	-0.005	46.33	1.265	-5.196	3.00	0.004*	-0.006
15.	AMS-MB-5-19	2.71	9.924	0.006	59.20	1.853	-5.237	3.00	-1.733	0.001
16.	KDS-1045	2.89	-2.509*	-0.007	47.87	0.983	-4.190	2.69	-8.391	-0.006
17.	MAUS-710	2.89	3.080	-0.004	54.38	2.509	-5.361	2.96	-2.312	-0.005
18.	JS-335(C)	3.00	1.826	-0.004	44.78	1.652	-4.958	2.89	-0.575	0.005
19.	JS-93-05(C)	2.91	-1.363	0.001	37.53	0.768	-5.267	2.93	6.951	-0.002
20.	JS-97-52(C)	2.47	-0.001*	-0.007	44.18	0.414	-5.120	2.91	-5.496	0.035*
21.	MAUS-71(C)	2.64	-1.147	0.002	44.82	1.572	-5.327	2.93	6.083	0.003
22.	MAUS-158(C)	3.09	3.080	-0.004	41.78	1.123	-5.441	3.02	0.293	-0.003
	Grand mean	2.83			45.58			2.92		
	SEm±	0.07			0.48			0.07		
	SEb±	2.39			0.27			4.39		

Table 3 : Continue..

Sl. No.	Variety	100 seed weight			Yield plant^{-1}			Yield plot^{-1}		
		$\bar{X}$	bi	S^2d_i	$\bar{X}$	bi	S^2d_i	$\bar{X}$	bi	S^2d_i
1.	MACS-1460	12.52	0.550	-0.035	17.15	0.673	-0.561	1.66	1.721	-0.006
2.	KDS-904	14.73	1.604*	-0.051	16.12	1.267	-0.040	1.64	1.032	-0.007
3.	MAUS-740	13.34	1.066	-0.046	17.97	1.113	-0.667	1.64	0.198	0.025
4.	AMS-1002	12.05	0.834	0.025	13.54	0.268	-0.571	1.42	1.442	-0.003
5.	KS-133	13.25	0.820	-0.008	16.48	0.939	0.018	1.58	1.829	0.004
6.	MACS-1543	12.84	1.579	-0.044	17.12	1.534*	-0.672	1.69	1.417	0.005
7.	KD-921	11.77	0.619	-0.034	10.66	-0.101	-0.382	1.39	1.633	-0.009
8.	MAUS-614	14.96	0.996	0.017	23.19	1.375	-0.648	1.86	0.931	0.008
9.	AMS-1003	11.94	1.023	0.082	14.27	0.658	-0.497	1.57	0.439	-0.002
10.	MACS-1505	12.77	0.574	0.059	16.16	0.278	-0.599	1.62	0.665	0.045*
11.	AMS-100-39-1	14.65	1.855	0.018	21.13	1.638*	-0.673	1.75	0.807	-0.009
12.	MACS-1520	13.05	0.909	-0.008	16.26	0.554	-0.603	1.58	2.108	0.002
13.	KDS-980	15.29	1.534	-0.030	19.79	1.325	-0.631	1.76	1.123	-0.008
14.	MAUS-706	13.79	1.323	0.009	18.83	1.402	-0.062	1.57	0.708	0.004
15.	AMS-MB-5-19	11.62	0.809	-0.051	20.29	1.332	-0.659	1.68	0.177	-0.003
16.	KDS-1045	11.98	1.330	-0.048	14.96	1.441	0.840	1.68	0.572	-0.001
17.	MAUS-710	13.39	0.626	0.006	20.97	1.239	0.240	1.64	1.329	0.085**
18.	JS-335 (C)	12.77	0.854	0.398**	16.07	1.058	-0.657	1.68	0.048	0.043*

Continue...

Sl. No.	Variety	100 seed weight			Yield plant^{-1}			Yield plot^{-1}		
		$\overline{X}$	bi	S^2d_i	$\overline{X}$	bi	S^2d_i	$\overline{X}$	bi	S^2d_i
19.	JS-93-05 (C)	13.95	0.844	0.002	14.95	0.995	-0.535	1.53	0.110*	-0.010
20.	JS-97-52 (C)	12.32	0.703	0.155*	15.50	0.934	-0.601	1.59	0.729	0.036*
21.	MAUS-71 (C)	13.17	0.515	0.110	16.70	0.923*	-0.673	1.52	1.628	0.104**
22.	MAUS-158 (C)	13.28	1.034	0.311**	16.39	1.155	-0.230	1.58	1.353*	-0.010
	Grand mean	13.16			17.02			1.62		
	SEm±	0.21			0.37			0.11		
	SEb±	0.20			0.17			0.48		

Table 3 : Continue..

Sl. No.	Variety	Oil content			Protein content		
		$\overline{X}$	bi	S^2d_i	$\overline{X}$	bi	S^2d_i
1.	MACS-1460	21.02	-2.723	-0.012	36.85	-10.299	0.046*
2.	KDS-904	20.24	2.587	-0.026	38.51	3.701	0.337**
3.	MAUS-740	20.94	1.709	-0.032	37.91	6.223	0.035
4.	AMS-1002	20.44	3.537	-0.012	35.97	3.464	-0.011
5.	KS-133	20.15	-2.537	-0.003	37.71	-6.770	0.157**
6.	MACS-1543	20.12	-1.996	-0.003	39.46	-6.076	0.114**
7.	KD-921	19.68	0.030	0.035	35.76	-2.683	0.204**
8.	MAUS-614	20.15	2.371	-0.034	34.46	0.777	-0.013
9.	AMS-1003	19.76	0.931	0.013	36.05	-3.500	0.012
10.	MACS-1505	19.30	6.496	0.020	39.18	8.646	0.386**
11.	AMS-100-39-1	20.61	3.408	-0.031	35.39	6.107	0.204**
12.	MACS-1520	21.05	0.291	-0.010	36.73	-1.725	0.251**
13.	KDS-980	20.62	-0.140	-0.016	36.73	0.845	0.046*
14.	MAUS-706	20.53	1.229	-0.032	35.33	2.577	-0.010
15.	AMS-MB-5-19	20.94	-0.291	-0.012	35.97	0.078	0.050*
16.	KDS-1045	19.86	-3.712	-0.027	37.15	-3.527	0.008
17.	MAUS-710	20.73	1.595	-0.022	34.13	1.691	-0.005
18.	JS-335(C)	20.84	1.622	-0.027	34.77	3.322	0.005
19.	JS-93-05(C)	20.89	1.195	-0.031	38.23	3.388	-0.005
20.	JS-97-52(C)	20.18	3.367	-0.030	37.32	8.674	0.015
21.	MAUS-71(C)	20.61	1.413	-0.009	35.30	2.865	0.022
22.	MAUS-158(C)	20.65	2.055	-0.025	37.05	2.742	-0.004
	Grand mean	20.42			36.64		
	SEm±	0.10			0.22		
	SEb±	2.01			5.53		

4.1. Days to 50% flowering

The data presented in (Table 3), indicated that out of 22 genotypes, 8 genotypes recorded high mean performance while 8 genotypes exhibited significant S^2di values. The genotypes, AMS-MB-5-19 exhibited higher mean, bi near to unity (bi=1) and less deviation from regression line these genotype suitable under all environment. The genotypes, KS-133 and JS-97-52 had high mean value than the general mean bi more than unity (b>1) and non-significant (S^2di) indicating that there superior for favorable environment. The non linear component was significant which indicate the unpredictable performance over the environments. Joshi et al. (2005), Rao and Eswari (2006), Dhillon et al. (2009) showed both linear and non linear component significant for days to 50% flowering.

4.2. Days to maturity

The genotypes KDS-921 exhibited greater adaptability as their higher mean than the grand mean with bi around unity and non-significant (s^2di) value. The genotypes KDS-980 exhibited higher mean, bi less than one (b<1) and less deviation from regression line these genotypes suitable under unfavorable environment. The genotype MACS-1520 showed low mean with bi around unity and non significant S^2di suggesting their early maturity with wider adaptability. Non linear component was significant and of higher magnitude indicating its major contribution for expression of trait. Joshi *et al*. (2005), Rao and Eswari (2006), Dhillon *et al*. (2009) noticed reported that non linear component significant for days to maturity.

4.3. Plant height

Thirteen genotypes recorded higher mean plant height than grand mean out of which MACS-1543 had stable performance as it had bi near unity and non significant S^2di indicating its suitability to varied environments. The Seven genotypes, AMS-1002, MAUS-614, KS-133, MACS-1505, KDS-1045, KDS-980 and MAUS-71 recorded high mean with bi>1 and non-significant (s^2di) indicating that there superior for favorable environment. Rao and Eswari (2006), Dhillon *et al*., (2009), Tyagi *et al*. (2009) stressed that both linear and non linear component were significant for G x E interaction.

4.4. No. of branches plant^{-1}

The genotypes, KDS-980 and MACS-1460 had higher mean than the grand mean bi near to unity (bi=1) and non-significant (S^2di) indicating that there superior for average response and stable under all environment. Among the genotypes, MACS-1505, MAUS-740, KDS-1045, MACS-1520, MAUS-158, AMS-100-39-1 and JS-335 had higher mean than the grand mean with bi was more than one (bi>1) and non-significant (s^2di) indicating that there superior for favorable environment. The genotypes viz. MAUS-614, KDS-904 and JS-97-52 exhibited higher mean, bi less than one (b<1) and less deviation from regression line these genotypes suitable under unfavorable environment. The non linear component was significant and of higher magnitude indicating its major contribution for expression of trait, Aremu *et al*. (2005), Rao and Eswari (2006), confirmed both linear and non linear component were significant for number of branches.

4.5. No.of pods plant^{-1}

Ten genotypes exhibited high mean performance than general mean. Genotypes, AMS-100-39-1, KDS-1045 and MAUS-706 had higher mean than the grand mean bi near to unity (b=1) and non-significant (s^2di) indicating that there superior for average response and stable under all environment. The genotypes viz. MACS-1460, KS-133, MACS-1543, AMS-MB-5-19 and MAUS-710 had higher mean than the grand mean bi more than unity (b>1) and non-significant (s^2di) indicating that there superior for favorable environment. The significance of non linear component of G×E interaction indicated unpredictable genotypic performance over the environments, Mondal et al. (2005); Rao and Eswari (2006), Dhillon et al. (2009), Tyagi et al. (2009); Tyagi et al. (2011) reported significance of linear and non linear component for this trait.

4.6. Number of seeds pod^{-1}

Genotypes viz. KDS-904, MAUS-740, MACS-1543, MAUS-614, MACS-1505, AMS-100-39-1, MACS-1520, KDS-980, AMS-MB-5-19, JS-93-05 and MAUS-71 had higher mean than the grand mean bi more than unity (b>1) and non-significant (s^2di) indicating that there superior for favorable environment. The genotypes, AMS-1002, AMS-1003, MAUS-706 and MAUS-158 had exhibited higher mean, bi less than one (b<1) and less deviation from regression line these genotypes suitable under unfavorable environment. Mondal *et al*. (2005), Ramana *et al*. (2006), Dhillon et al. (2009); Tyagi et al. (2009) stressed both linear and non linear components significant for this trait.

4.7. 100 seed weight

Eleven genotypes recorded higher mean than grand mean out of which two genotypes, MAUS-740, MAUS-614 showed high mean with bi around unity and non significant S^2di values suggesting their adaptability to varied environment. Three genotypes, KDS-980, KDS-904, MAUS-706 had high mean with bi>1 and non significant S^2di values showing their suitability for rich environment. The genotypes, KS-133, JS-93-05, MAUS-71, MAUS-710 showed high mean with bi<1 and non significant S^2di values showing their suitability for poor environment. Significant non linear component of G x E contributed major portion of G x E. Rao and Eswari (2006), Dhillon *et al*., (2009), Tyagi *et al*. (2009) reported that both linear and non linear component were significant for this trait.

4.8. Grain yield plant^{-1} (g)

It is revealed from table 15 that nine genotypes exhibited higher mean seed yield than grand mean out of which two genotypes MAUS-710, MAUS-740, were stable for varied environments as they recorded high mean values with bi near unity and non significant S^2di values and genotypes, MACS-1543, MAUS-614, AMS-100-39-1, KDS-980, MAUS-706 and AMS-MB-5-19 showed high mean with bi>1 and non significant S^2di values suggesting their adaptability to favourable environment. The genotypes MACS-1460 showed high mean with bi<1 and non significant S^2di values suggesting their adaptability to unfavourable environment. The pooled deviation and pooled error was significant suggesting its importance in expression of character. Mondal *et al*. (2005), and Ramana et al. (2006); Rao and Eswari (2006), Tyagi et al. (2009) reported both linear and non linear components showed significant for the traits.

4.9. Grain yield plot^{-1} (kg)

The genotypes, MAUS-614, KDS-904, KDS-980 had higher mean than the grand mean bi near to unity (b=1) and non-significant (s^2di) indicating that there superior for average response and stable under all environment. Genotypes MACS-1460, MACS-1543, had higher mean than the grand mean bi more than unity (b>1) and non-significant (s^2di) indicating that there superior for favorable environment. The pooled deviation and pooled error was significant suggesting its importance in expression of character. Mondal et al. (2005), Ramana et al. (2006); Tyagi et al. (2009) reported both linear and non linear components showed significant for grain yield per plot.

4.10. Oil content (%)

The genotypes, JS-93-05, MAUS-706, showed high mean bi near unity and non significant S^2di values indicating stability for this character over all environments. The nine genotypes viz. MACS-1460, KDS-904, MAUS-740, AMS-1002, AMS-100-39-1, MAUS-710, JS-335 MAUS-71, MAUS-158, showed high mean with bi>1 and non-significant (s^2di) indicating that there superior for favorable environment. The genotypes viz. MACS-1520, KDS-980, AMS-MB-5-19 exhibited higher mean, bi less than one (b<1) and less deviation from regression line these genotypes suitable under unfavorable environment. The significance of non linear component of G x E interaction indicated unpredictable genotypic performance over environments. Gurdeep Singh et al. (2003); Ramana et al. (2006) noted both linear and non linear component were significant for this trait.

4.11. Protein content (%)

Twelve genotypes recorded higher mean than grand mean. The five genotypes, KDS-1045, JS-97-52, MAUS-740, JS-93-05, MAUS-158 exhibited high mean with bi more than one bi>1 and non significant S^2di values showing their suitability for rich environment. The non linear component was significant for this character. Ramana et al. (2006) observed that both linear and non linear component were significant for this trait.

5. Conclusion

The promising genotypes can be released as new varieties after further testing or used as parents for generating new varieties with wide adaptability MAUS-740, MAUS-710 over environments or with specific adaptation (KDS-921, MACS-1543, AMS-MB-5-19, KDS-1045, AMS-100-39-1, MACS-1460, JS-93-05, MAUS-706) to a particular environment for desirable attributes.

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