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GENOTYPE X ENVIRONMENT INTERACTION AND STABILITY ANALYSIS OF ADVANCE BREEDING GENOTYPES OF SOYBEAN FOR YIELD AND ITS COMPONENTS IN CENTRAL NARMADA REGION OF M.P.

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ABSTRACT

Forty five advance breeding genotypes of soybean were evaluated for stability over three environments, in three seasons for two years i.e. *Kharif* 2013, *Rabi* 2013-14, *Kharif* 2014 for phenological and economic traits at JNKVV, Jabalpur (Central Narmada region). The mean sum of square of variance revealed that genotypic differences were highly significant (P<0.01) for seven traits viz., vegetative phase, plant height, number of pod cluster/plant, number of branches/plant, number of seeds/plant,100 seed weight, seed yield/plant. Mean sum of squares due to Environment (linear) was found highly significant for all the traits under study. The genotype x environment interaction showed significant values for five traits viz., vegetative phase, reproductive phase, number of pods/plant, number of nodes/plant, biological yield/plant. The mean sum of squares due to genotype × environment (linear) component against pooled deviation were found significant among the traits *viz*., plant height, number of branches/plant, number of seeds/plant, biological yield/plant, seed yieldplant, 100 seed weight and harvest index. JS 335, JS 93-05, JS 95-60, JS 97-52, JS 20-34, JS 20-73, JS 20-84, JS 20-85, JS 20-90, JS 20-93, JS 20-94, JS 20-98, JSM 246 were identified as stable genotypes over all environments exhibited constant performance for more than four traits including economic traits. Whereas JS 20-64, JS 20-73, JS 20-94, JS 20-96, JSM 302, Bragg were found appropriate for poor environments. JS 20-53, JS 20-41, RVS 2007-4 and JSM 283 found stable for favorable environment. On the basis of genetic divergence analysis over three environments, most diverse genotypes identified were JS 335, JS 20-34, JS 20-29, JS 20-41, JS 20-50, JS 20-59, JS 20-65, JS 20-69, JS 20-71, JS 20-89, JS 20-92, JS 20-94, JS 20-95, JS 20-96, JS 20-98, JSM126, JSM 127, JSM 175, JSM 230, JSM 242, JSM 283, JSM 302 and Bragg. On account of results from genetic divergence and stability analysis above genotypes were considered as potential sources to be utilize in hybridization programs to accomplish the desirable future varieties of soybean with wider adaptability and better stability.

Key words : *Jabalpur, soybean, stability, GxE*

Soybean [*Glycine max* (L.) Merrill], a self pollinated diploid (2n=2x=40) food legume belonging to family *Leguminosae* syn. *Fabaceae*, subfamily *Papilionoideae* is originated in north and central China. Soybean ranks first amongst oilseed crops in the world and India both. Beside this phenomenal growth, the yield level in soybean is hovering around 1.2 tons/ha which is quite low. Yield is a complex entity influenced by several phenological, yield traits and as well as fluctuations in environment. Soybean being a self pollinated oilseed crop faces the constraint of narrow genetic base. In recent years soybean productivity has been declining due to impact of abiotic stresses in one or the other region or season or year and along with rainfall instability with lack of appropriate breeding strategies. It is mandatory to identify genotypes and donors which can combat with the changing climate and low or high rainfall pattern. Development of a stable variety is one of the major objectives of all breeding programmes. Phenotypically stable varieties are usefully sought for commercial production of crop plants. It is necessary to screen phenotypically stable genotypes, which could perform more or less uniformly under different environmental conditions. Several models have been proposed for stability analysis. According to (1) model, a stable variety is one, which has above average mean yield, a regression coefficient of unity (bi=1) and non-significant mean square deviations from regression (S^2di=0). The high value of regression (bi>1) indicates that the variety is more responsive for input rich environment while, low value of regression (bi<1) is an indication that the variety may be adopted in poor environment. The stability analysis may be more meaningful when the material is tested over various environments.

MATERIALS AND METHODS

In the present study, a set of 45 advance breeding genotypes of soybean were evaluated in three environments (three seasons) i.e. during E_1 (*Kharif* 2013), E_2 (*Rabi* 2013-14) and E_3 (*Kharif* 2014) for phenological and economic traits under AICRP on Soybean at Seed Breeding farm, JNKVV, Jabalpur (Central Narmada region). Twelve phenological and economic traits were studied on the basis of five random competitive plants selected from each line in each replication. The mean data of 10 plants were subjected to Stability analysis by (1) model.

RESULTS AND DISCUSSION

Analysis of variance : Significant G x E interaction suggested the linear function of the additive environment effects and allows for evaluation of genotypes for stability across the environments. (1) emphasized the need of considering both the linear (bi) and non-linear (S^2di) components of interaction in judging the stability of a genotype. The result of analysis of variance revealed that genotypic differences were highly significant (P<0.01) for seven traits (Table-1) viz., vegetative phase, plant height, number of pod cluster/plant, number of branches/plant, number of seeds/plant,100 seed weight, seed yield/plant. Similarly significant variance of stability were observed by (2) for number of pods/plant, 100 seed weight and seed yield/plant, for seed yield/plant. Mean sum of squares due to Environment (linear) was found highly significant for all the traits viz., vegetative phase, plant height, number of pod cluster/plant, number of branches/plant, number of seeds/plant,100 seed weight, seed yield/plant, reproductive phase, number of pods/plant, number of nodes/plant, biological yield and harvest index. Similar findings have been reported by for number of pods/plant, (3) for number of nodes/plant, number of pods/plant, (4) for number of pods/plant and (5) for number of pods/plant and biological yield/plant. The genotype x environment interaction showed significant values for five traits viz., vegetative phase, reproductive phase, number of pods/plant, number of nodes/plant, biological yield/plant.

Stability for individual traits : The phenotypic stability of genotypes was estimated by mean performance over the environments, regression coefficient (bi) and deviation from regression (S^2di).

Vegetative phase : Among the genotypes tested variety JS 20-69,JS 20-82, JS 20-50, JS 20-96, JS 20-59, JSM 302 and JSM 175 were having higher mean than population mean, unit regression coefficient (bi<1) and minimum mean square deviation from regression (S^2di~0) (Table 2) indicating that these genotypes were having above average stability. Other genotypes JS 20-93, JS 20-53, JS 20-89, JS 20-98, JSM-7, JSM-20, JSM-127 and JSM 242 were also stable and are able to perform better under favorable environmental condition (Table-2).

Reproductive phase : Among the genotypes tested high mean coupled with high regression coefficient (bi>1) along with minimum mean square deviation from regression (S^2di~0) (Table 2) was observed in genotypes JSM 230, JSM 7, JSM 207, JSM 20, JSM 126, JS 20-88, JS 20-53, JS 20-98, JS 20-69, JS 20-91, JS 20-94, JS 20-82, JS 20-29, JS 20-41, JS 20-95 and Bragg indicating that these genotypes were showing positive interaction with favorable environment condition. JSM 302, JSM 146, JS 20-96, JS 20-70 and JS 20-71 were showing above average stability.

Plant height : Among the genotype JS 20-79 was found to be stable with equal to grand mean, regression coefficient close to unity (bi~1) and non-significant mean square deviation from regression (S^2di=0) (Table. 2). Other genotypes JS 93-05, JS 335, JS 97-52, Bragg and RVS 2007-4 exhibited high mean value with regression coefficient less than unity (bi<1) and non-significant mean square deviation from regression indicating their above average stability and these genotypes may perform better in poor environmental conditions.

Number of pods/plant : Among the genotypes JSM 302 was found to be having high mean greater than grand mean, regression coefficient less than unity (bi<1) and non-significant mean square deviation from regression (S^2di~0), can perform better in poor environmental condition while genotype JS 20-90 was found to be having high mean greater than grand mean, regression coefficient equal to unity (bi=1) and non-significant mean square deviation from regression (S^2di~0) having above average stability (Table-3).

Number of pod cluster/plant : Among the genotype JS 20-87, JS 20-29, JS 97-52, JS 20-79, JS 20-86, JS 20-41, JS 20-70, JS 20-94 and JSM 302 (Table-3) was found to be having high mean greater than grand mean, regression coefficient less than unity (bi<1) and non-significant mean square deviation from regression (S^2di~0) indicating that they can perform better in poor environmental condition.

Number of nodes/plant : Among the genotypes tested JS 20-64, JS 20-59, JS 20-99, JS 20-86, JS 97-52, JS 20-79, JS 20-91, JS 20-73, JSM 230, JSM 175, JSM 302, JSM 146, JSM 7, JSM 126, NRC 37 and Bragg were having higher mean than population mean, unit regression coefficient (bi<1) less than one and minimum mean square deviation from regression (S^2di~0) (Table-3) indicating that these genotypes were having above average stability and are able to perform better under poor environmental condition.

Number of branches/plant : Among the genotypes tested JS 20-29, JS 20-41, JS 20-50, JS 20-53, JS 20-59, JS 20-64, JS 20-73, JS 20-75, JS 20-90 and JS 20-94 were having higher mean than population mean, unit regression coefficient (bi<1) less than one and minimum mean square deviation from regression (S^2di~0) (Table-4), can perform better under poor environmental condition.

Number of seeds/plant : Among the genotypes JSM 302 was found to be having high mean greater than grand mean (Table-4), regression coefficient less than unity (bi<1) and non-significant mean square deviation from

Table-1 : Stability ANOVA Summary of traits.

	DF	Vegetative phase	Reproductive phase	Plant height	Num of branches/plant	Number of pods/plant	Number of pod cluster/plant
Rep within Env.	6	0.246 *	0.765	4.741	0.074	0.623	2.348
Varieties	49	39.222 ***	29.703	44.491 **	0.792 *	60.545	21.974***
Env.+ (Var.* Env.)	100	88.904 ***	162.941 ***	39.834 *	1.543 ***	504.315***	19.920***
Environments	2	4013.059 ***	7064.788 ***	745.063 ***	53.448 ***	22383.47***	481.510***
Var.* Env.	98	8.820 ***	22.087 ***	25.442	0.484	57.802***	10.500
Environments (Lin.)	1	8026.117 ***	14129.580 ***	1490.125***	106.896 ***	44766.950***	963.019***
Var.* Env.(Lin.)	49	17.537 ***	43.514 ***	27.016	0.477	115.118***	12.114
Pooled Deviation	50	0.100	0.646	23.391 ***	0.481 ***	0.476	8.708
Pooled Error	294	0.681	0.947	1.550	0.072	0.523	2.030
Total	149	72.566	119.124	41.366	1.296	358.377	20.595

	DF	Num of nodes/plant	Num of seeds/plant	Biological yield (g)	100 seed weight (g)	Harvest index	Seed yield/plant
Rep within Env.	6	7.791 ***	4.771	0.411	0.052	0.060	0.767
Varieties	49	7.881	566.359 ***	24.617	1.473 **	5.905 ***	50.307
Env.+ (Var.* Env.)	100	9.358 ***	426.294 **	18.695 **	0.777	3.953 *	109.919 **
Environments	2	56.631 **	9054.262 ***	100.178 **	3.187 *	84.495 ***	3011.128 ***
Var.* Env.	98	8.393 ***	250.213	17.032 **	0.728	2.310	50.711
Environments (Lin.)	1	113.262 ***	18108.520 ***	200.356 ***	6.374 **	168.990 ***	6022.256 ***
Var.* Env.(Lin.)	49	15.505 ***	264.497***	25.491 ***	0.782	2.284	50.780
Pooled Deviation	50	1.255	231.211 ***	8.401 ***	0.661 ***	2.288 ***	49.629 ***
Pooled Error	294	7.389	3.334	0.199	0.040	0.043	0.578
Total	149	8.872	472.356	20.642	1.006	4.595	90.315

regression (S^2di~0) indicating that this genotype can perform better in poor environmental condition.

Biological yield/plant : Among the genotypes JS 20-64 and JS 20-96, were stable as these genotypes were having high mean value, unit regression coefficient (bi<1) less than one and non-significant mean square deviation from regression (S^2di~0) (Table-4).

100 seed weight : Among the genotypes JS 20-53, JS 20-94, JS 20-79, JS 20-85, JSM 302, JSM 127, JSM 175, JSM 7, JSM 283 and JSM 230 were showing above average stability with high mean value, unit regression coefficient (bi<1) and nearly zero mean square deviation from regression (S^2di~0) (Table 5). Other genotypes JS 20-41, JS 20-50, JS 20-96, JS 20-73, JS 20-80, JS 20-86, JS 20-64, JS 95-60, JSM 302, JSM 127, JSM 175, JSM 283, JSM 230 and NRC 37 exhibited below average stability and these genotypes cannot perform better in any environmental condition.

Harvest index: Among the genotypes JS 20-59 and JS 20-41 were showing above average stability with high mean value, unit regression coefficient (bi<1) and nearly zero mean square deviation from regression (S^2di~0) (Table 5).

Seed yield/plant : Among the genotypes JS 20-88, JS 20-99, JS 20-65, and JSM 127 were showing above average stability with high mean value, unit regression coefficient (bi<1) and nearly zero mean square deviation from regression (S^2di~0) (Table-5).

The stability of genotypes for seed yield and its components in soybean has also been reported by (6, 7) for 100 seed weight, (8, 9, 10, 11) found genotype x environment interaction showed significant difference for number of pods/plant, number of nodes/plant, biological yield/plant and environment (linear) was significant for all traits. The mean sum of squares due to genotype × environment (linear) component against pooled deviation were found significant among the traits *viz.,* plant height, number of branches/plant, number of seeds/plant biological yield/plant, seed yield/plant,100 seed weight and harvest index. In conformity with the present findings (12) found significance of mean squares due to genotype × environment (linear) component against pooled deviation for biological yield plant^{-1} and number of pods/plant, (11) found significance due to genotype × environment (linear) component against pooled deviation for number of branches/plant and seed yield/plant.

Stable genotypes over environments : JS 335, JS 93-05, JS 95-60, JS 97-52, JS 20-34, JS 20-73, JS 20-84, JS 20-85, JS 20-90, JS 20-93, JS 20-94 JSM 127, JSM 246 are identified stable genotypes exhibited stable performance for more than four traits including most

Table-2 : Estimation of stability parameters for economic traits.

Genotypes		Vegetative phase			Reproductive phase			Plant height		
		µ Mean	þi	o^{2}di	µ Mean	þi	o^{2}di	µ Mean	þi	o^{2}di
1	JS 335	37.56	0.72	-0.67	63.56	0.11	-0.52	34.24	1.69	0.27
2	JS 93-05	39.44	1.44	-0.67	62.67	0.34	0.54	42.56	2.15	-1.59
3	JS 95-60	29.22	1.36	-0.57	62.56	0.35	-0.94	42.99	0.31	-1.44
4	JS 97-52	42.33	1.19	-0.66	66.89	0.79	-0.90	45.66	2.47	1.87
5	JS 20-29	39.22	1.49	-0.64	63.78	1.62	-0.74	46.22	2.78	-1.54
6	JS 20-34	30.78	0.67	-0.59	57.56	0.54	-0.65	36.67	0.01	15.81
7	NRC 37	42.33	1.09	-0.06	62.44	1.06	-0.81	43.77	0.08	18.53
8	Bragg	39.78	1.05	-0.64	66.44	1.16	-0.68	38.36	0.37	-1.58
9	JS 20-41	37.78	0.89	-0.43	63.00	1.05	-0.93	36.71	1.41	42.90
10	JS 20-50	41.11	0.79	-0.62	58.22	0.28	-0.92	40.93	0.55	4.25
11	JS 20-53	39.33	0.90	-0.61	66.11	1.21	-0.94	42.69	1.18	91.88
12	JS 20-59	42.44	0.44	-0.66	58.11	0.96	-0.33	44.63	0.71	-1.37
13	JS 20-64	44.56	1.01	-0.59	61.67	1.09	-0.21	42.97	0.05	28.22
14	JS 20-65	43.89	1.14	-0.65	61.78	1.13	-0.91	40.64	0.59	19.97
15	JS 20-69	40.22	0.95	-0.63	65.67	1.38	0.11	37.29	0.86	12.50
16	JS 20-70	37.56	0.43	-0.66	61.11	0.55	-0.84	39.89	3.35	-0.23
17	JS 20-71	46.78	1.25	-0.66	60.00	0.97	-0.94	41.29	1.12	14.56
18	JS 20-73	42.00	1.39	-0.65	58.89	1.18	13.54	46.64	-0.02	18.93
19	JS 20-74	38.56	1.14	-0.57	63.67	0.73	-0.94	39.67	0.62	10.77
20	JS 20-75	37.22	1.36	-0.57	64.33	0.61	-0.93	41.40	1.54	50.80
21	JS 20-79	44.56	1.14	-0.65	59.33	0.85	-0.89	46.02	2.43	24.93
22	JS 20-80	38.78	1.38	-0.67	56.67	1.12	-0.92	44.43	-0.57	48.04
23	JS 20-82	36.44	0.89	-0.67	64.33	1.09	-0.64	34.11	1.32	118.22
24	JS 20-85	36.67	0.52	-0.04	58.33	0.80	-0.88	43.11	2.54	-1.61
25	JS 20-86	41.00	0.93	-0.67	62.44	0.91	-0.86	45.79	1.22	-1.61
26	JS20-87	45.33	1.06	-0.67	60.33	1.19	1.13	47.00	-0.42	0.63
27	JS 20-88	37.78	0.54	-0.57	66.11	1.47	-0.24	37.78	1.08	-0.06
28	JS 20-89	39.33	0.65	-0.59	61.67	1.21	-0.46	33.50	1.04	24.76
29	JS 20-90	45.33	1.84	-0.59	56.89	1.08	-0.63	44.74	-0.20	23.31
30	JS 20-91	35.22	0.78	-0.67	65.33	1.46	-0.25	43.49	-0.18	8.45
31	JS 20-92	46.44	1.63	-0.46	56.11	1.04	-0.93	34.06	-0.63	19.69
32	JS 20-93	39.44	0.83	-0.45	63.56	0.84	0.43	41.12	0.77	0.85
33	JS 20-94	39.11	1.15	-0.66	64.56	1.32	-0.68	43.13	1.13	38.18
34	JS 20-95	40.78	1.34	-0.29	63.00	1.29	-0.69	37.11	0.89	27.44
35	JS 20-96	42.00	0.74	-0.67	61.22	0.93	-0.91	43.44	0.97	58.66
36	JS 20-98	38.44	0.99	-0.59	66.11	1.28	-0.88	38.13	1.78	19.97
37	JS 20-99	45.22	1.01	-0.59	59.00	0.83	-0.94	46.20	1.54	4.06
38	RVS 2007-4	43.44	1.54	-0.63	56.11	0.65	-0.93	45.18	2.09	7.88
39	JSM 7	38.67	0.61	-0.51	68.67	1.92	-0.21	32.99	0.62	64.90
40	JSM 20	39.78	0.89	-0.67	63.11	1.04	-0.59	33.54	1.03	37.84
41	JSM 126	44.00	1.10	-0.58	62.78	1.30	-0.75	38.19	-0.40	53.37
42	JSM 127	38.67	0.81	-0.67	62.00	1.07	-0.83	39.02	2.39	3.72
43	JSM 146	43.00	1.26	0.00	61.56	0.93	-0.86	40.04	0.22	8.25
44	JSM 175	40.56	0.85	-0.67	60.67	1.00	-0.57	40.63	0.28	10.85
45	JSM 207	36.78	1.21	-0.66	64.89	1.32	1.19	39.73	1.04	1.53
46	JSM 230	37.56	0.46	-0.66	69.11	2.15	-0.37	41.27	2.42	10.96
47	JSM 242	37.89	0.43	-0.55	63.22	0.40	-0.04	41.92	1.56	4.16
48	JSM 271	34.89	0.75	-0.61	59.56	0.59	-0.93	37.81	1.59	130.65
49	JSM 283	42.22	1.07	-0.64	61.11	1.04	-0.93	40.72	0.82	1.78
50	JSM 302	42.44	0.89	-0.47	61.89	0.79	-0.88	40.44	-0.20	15.56
Population Mean		40.078			62.162			40.798		

Table-3 : Estimation of stability parameters for economic traits.

Genotypes		Number of pods/plant			Number of nodes/plant			Number of pod cluster/plant		
		µ Mean	þi	o²di	µ Mean	þi	o²di	µ Mean	þi	o²di
1	JS 335	27.067	0.870	34.950	9.411	0.230	-7.150	16.589	1.170	3.150
2	JS 93-05	25.094	0.770	-4.940	9.467	-0.120	-7.260	16.322	0.330	-0.980
3	JS 95-60	20.578	0.620	-6.070	9.633	-0.040	-7.390	14.311	-0.580	14.180
4	JS 97-52	42.556	1.340	-5.630	11.011	0.870	-5.950	24.722	2.490	-1.470
5	JS 20-29	35.241	1.130	343.940	9.844	1.190	1.370	24.900	0.640	-2.020
6	JS 20-34	34.861	1.100	42.560	9.567	-0.380	-6.950	20.733	1.830	21.810
7	NRC 37	47.317	1.460	-3.410	11.078	0.350	-6.970	21.567	1.480	17.930
8	Bragg	29.157	0.870	-0.280	11.200	0.540	-7.150	17.444	0.990	1.410
9	JS 20-41	36.089	1.040	46.560	10.333	1.550	-6.680	21.767	0.270	-1.540
10	JS 20-50	29.886	0.880	-4.590	10.500	0.550	-6.280	19.833	-0.240	2.300
11	JS 20-53	35.578	1.070	12.560	10.500	1.070	-7.260	22.044	0.940	4.860
12	JS 20-59	32.824	0.940	42.200	11.356	-0.400	-7.230	18.411	0.780	-0.610
13	JS 20-64	34.796	1.010	26.030	11.456	0.220	-6.570	20.978	0.390	1.200
14	JS 20-65	33.270	1.000	-4.570	11.300	1.480	-7.290	21.911	0.240	18.070
15	JS 20-69	28.389	0.840	-0.970	9.322	0.770	-6.530	18.667	1.290	0.870
16	JS 20-70	31.817	0.920	28.420	10.011	1.850	-5.310	20.178	0.660	-1.860
17	JS 20-71	43.622	1.400	135.060	11.289	1.100	-5.690	24.900	1.770	21.350
18	JS 20-73	36.406	1.030	108.010	10.789	-0.140	-5.540	20.178	1.050	3.250
19	JS 20-74	27.406	0.790	-0.270	10.278	0.410	-6.280	20.544	-0.510	3.610
20	JS 20-75	33.812	1.000	12.400	10.289	1.950	-7.320	19.511	1.750	-1.600
21	JS 20-79	36.844	1.140	4.880	10.967	0.840	-6.150	22.833	1.030	-1.210
22	JS 20-80	33.492	1.050	64.620	10.278	0.020	-2.210	19.278	1.180	18.030
23	JS 20-82	23.851	0.680	2.060	9.260	1.450	-7.120	18.322	1.810	11.550
24	JS 20-85	24.994	0.710	0.060	10.844	1.440	-7.120	15.722	-0.800	19.750
25	JS 20-86	36.173	1.060	43.220	11.111	0.420	-6.900	22.067	1.440	-1.760
26	JS20-87	40.196	1.230	-5.410	10.889	1.580	-3.100	25.300	1.200	0.360
27	JS 20-88	33.524	1.010	2.680	10.089	1.030	-6.610	18.000	1.300	-1.760
28	JS 20-89	30.289	0.930	-5.610	9.967	1.320	-7.050	16.611	1.080	3.820
29	JS 20-90	32.912	1.060	119.780	10.222	0.270	-6.830	19.022	2.160	3.960
30	JS 20-91	38.717	1.180	-0.780	10.833	0.290	-6.530	18.478	1.380	1.810
631	JS 20-92	27.667	0.820	23.000	21.044	18.580	4.960	17.356	1.480	2.690
32	JS 20-93	33.629	1.060	31.390	10.222	0.670	-6.260	18.944	1.500	-2.020
33	JS 20-94	37.539	1.170	60.120	10.044	1.350	-4.630	20.122	0.490	-0.930
34	JS 20-95	33.794	1.050	31.370	10.211	1.160	-4.360	16.267	0.340	13.280
35	JS 20-96	41.133	1.280	7.120	9.422	0.970	-5.960	18.322	1.000	0.510
36	JS 20-98	32.824	1.030	48.230	10.022	0.780	-7.360	20.767	0.460	17.900
37	JS 20-99	30.924	0.900	22.640	11.200	0.100	-7.300	24.978	0.470	37.490
38	RVS 2007-4	31.387	0.990	64.430	10.400	0.410	-6.740	21.467	-0.710	10.610
39	JSM 7	26.031	0.780	6.930	10.800	0.300	-7.340	18.267	0.940	-1.250
40	JSM 20	31.586	0.920	11.170	9.667	0.990	-6.630	16.022	1.480	11.340
41	JSM 126	35.207	1.060	26.570	10.800	0.360	-7.050	18.622	1.400	8.170
42	JSM 127	32.430	0.970	10.780	10.622	0.950	-6.380	17.044	0.220	0.430
43	JSM 146	32.696	0.990	17.310	11.133	-0.020	-7.360	18.833	2.370	10.310
44	JSM 175	33.569	1.020	9.680	11.311	0.590	-6.900	20.700	1.790	15.950
45	JSM 207	27.640	0.890	-3.100	10.511	-1.190	-7.300	15.122	1.930	17.840
46	JSM 230	31.956	0.940	13.540	11.533	0.370	-7.380	19.422	1.150	4.070
47	JSM 242	29.410	0.890	-5.440	10.533	0.500	-7.210	18.611	1.430	0.120
48	JSM 271	26.009	0.810	-5.610	10.067	-0.130	-7.370	16.989	0.070	8.210
49	JSM 283	35.286	1.060	15.720	10.400	1.270	-6.730	22.033	2.380	22.170
50	JSM 302	40.192	1.250	-5.140	11.267	0.280	-6.750	22.522	1.330	-1.780
	Population Mean	32.293			10.686			19.671		

Table-4 : Estimation of stability parameters for economic traits.

Genotypes		Number of branches/plant			Number of seeds/plant			Biological yield/plant		
		µ Mean	þi	o²di	µ Mean	þi	o²di	µ Mean	þi	o²di
1	JS 335	3.200	0.96	10.34	62.333	1.430	-3.170	13.934	0.170	9.220
2	JS 93-05	1.867	0.32	1.02	60.222	0.660	6.200	12.734	-1.590	2.920
3	JS 95-60	2.011	0.21	-0.07	51.000	0.700	-0.020	13.119	-1.410	3.810
4	JS 97-52	3.756	1.51	0.02	104.778	1.350	17.050	21.133	-1.640	7.300
5	JS 20-29	4.078	0.10	1.15	85.667	1.880	708.310	21.426	3.260	24.580
6	JS 20-34	2.889	0.37	0.25	77.556	1.840	8.810	16.883	-1.400	7.310
7	NRC 37	4.022	1.20	-0.06	98.110	2.890	1264.750	20.810	-2.600	47.740
8	Bragg	3.667	1.21	-0.06	62.111	1.280	117.960	14.237	-0.350	0.700
9	JS 20-41	3.867	0.64	0.28	85.222	0.360	87.950	19.902	0.030	1.810
10	JS 20-50	3.756	0.82	-0.07	82.889	0.200	330.330	19.523	4.350	0.810
11	JS 20-53	4.400	0.67	0.05	89.778	0.690	243.860	21.194	4.580	1.370
12	JS 20-59	4.033	0.77	-0.07	87.556	0.110	39.580	17.371	1.290	6.270
13	JS 20-64	4.200	0.88	-0.02	79.222	1.180	107.480	20.594	-0.110	-0.160
14	JS 20-65	3.544	0.35	-0.07	87.556	0.330	66.230	20.528	2.510	1.900
15	JS 20-69	3.722	1.12	0.69	82.333	-0.850	401.350	17.146	1.910	8.740
16	JS 20-70	4.322	1.35	-0.07	75.889	0.660	90.530	19.749	3.360	-0.200
17	JS 20-71	4.156	1.04	0.15	103.222	1.860	447.400	22.461	2.250	0.070
18	JS 20-73	4.200	0.90	0.21	89.556	0.050	16.300	20.224	-2.260	1.570
19	JS 20-74	3.600	0.58	-0.06	67.000	0.490	-3.260	20.721	5.980	24.970
20	JS 20-75	3.667	0.90	0.94	86.000	0.470	0.360	20.110	1.730	17.130
21	JS 20-79	3.611	0.80	0.16	101.889	1.040	190.330	23.237	3.530	32.260
22	JS 20-80	3.578	0.36	2.28	71.889	2.320	-3.350	17.570	-1.670	3.960
23	JS 20-82	3.378	0.69	0.39	79.778	-1.080	1140.940	21.347	7.340	10.330
xc24	JS 20-85	3.156	0.22	0.37	72.000	-0.230	2.360	18.667	6.100	23.300
25	JS 20-86	3.800	1.05	-0.03	100.889	1.670	14.690	20.727	3.600	0.870
26	JS20-87	3.956	1.17	-0.06	103.667	1.640	74.690	23.893	1.700	20.290
27	JS 20-88	3.400	0.96	0.10	83.556	0.640	-2.440	19.762	3.190	5.970
28	JS 20-89	2.933	0.77	1.33	83.333	0.140	7.340	17.061	0.820	6.430
29	JS 20-90	3.933	1.22	-0.03	79.111	1.400	212.730	17.060	-2.440	8.100
30	JS 20-91	3.500	1.15	0.04	90.667	1.080	11.740	16.811	-0.910	-0.170
31	JS 20-92	3.589	1.62	0.55	70.333	0.270	132.150	15.221	-3.100	3.210
32	JS 20-93	3.178	0.73	0.20	88.556	1.380	298.260	17.959	-1.090	19.270
33	JS 20-94	3.800	0.61	0.03	91.444	1.420	175.530	19.787	1.560	14.770
34	JS 20-95	3.533	0.50	-0.06	78.667	1.700	24.740	18.129	-0.260	5.600
35	JS 20-96	3.978	1.19	0.28	104.333	1.110	-3.020	21.283	0.860	-0.190
36	JS 20-98	4.000	1.19	0.70	87.889	0.530	507.420	19.688	2.790	3.100
37	JS 20-99	3.967	1.08	-0.03	87.222	-0.580	185.210	23.020	2.390	36.900
38	RVS 2007-4	3.844	1.12	-0.07	85.333	0.780	298.250	18.726	3.930	-0.110
39	JSM 7	3.611	1.67	-0.06	54.333	1.560	443.560	14.100	0.070	0.650
40	JSM 20	3.467	0.55	0.01	65.000	1.730	643.270	12.809	-0.900	9.860
41	JSM 126	3.044	0.90	-0.06	76.667	1.740	602.970	17.873	-2.270	3.170
42	JSM 127	3.978	1.63	-0.07	97.222	-0.630	99.620	20.929	4.090	7.380
43	JSM 146	3.467	1.54	-0.07	68.556	1.550	414.040	15.120	-2.520	5.410
44	JSM 175	3.022	1.03	0.08	84.000	1.420	87.410	18.996	1.960	4.270
45	JSM 207	3.244	2.10	-0.06	63.333	2.180	86.130	15.043	-0.340	-0.040
46	JSM 230	4.133	1.38	0.03	82.333	1.720	303.100	17.608	0.340	-0.200
47	JSM 242	3.900	1.48	-0.04	70.667	0.730	9.560	15.167	2.430	13.510
48	JSM 271	3.689	1.90	0.06	55.111	1.520	125.590	14.373	0.210	0.980
49	JSM 283	3.933	1.62	-0.02	86.556	2.160	67.610	18.003	-1.020	1.270
50	JSM 302	4.444	1.90	-0.07	96.667	1.510	293.270	19.192	-0.470	1.880
Population Mean		3.640			81.580			18.459		

Table-5 : Estimation of stability parameters for economic traits.

Genotypes		100 seed weight			Harvest index			Seed yield plant		
		µ Mean	þi	o²di	µ Mean	þi	o²di	µ Mean	þi	o²di
1	JS 335	6.952	0.350	0.250	33.258	0.710	0.500	4.683	1.06	-0.04
2	JS 93-05	7.494	0.120	0.000	35.800	-0.240	26.700	4.509	0.53	-0.03
3	JS 95-60	8.078	1.260	0.290	31.410	0.210	3.580	4.139	0.69	0.14
4	JS 97-52	7.367	-1.870	1.010	37.302	0.430	205.680	7.676	0.69	1.58
5	JS 20-29	8.836	2.490	1.380	35.444	1.100	50.150	7.786	2.32	9.91
6	JS 20-34	7.817	-1.930	0.020	34.241	0.090	23.510	5.778	0.93	-0.02
7	NRC 37	8.110	3.705	0.520	38.186	1.920	48.490	8.544	3.54	9.60
8	Bragg	7.164	1.480	-0.030	31.794	1.530	8.540	4.489	1.14	0.48
9	JS 20-41	9.223	5.140	0.280	38.062	0.940	0.340	7.608	1.30	0.32
10	JS 20-50	9.008	4.280	0.090	42.078	1.280	22.360	7.880	1.09	3.02
11	JS 20-53	9.262	-0.660	-0.030	41.291	1.210	10.520	8.371	0.63	2.40
12	JS 20-59	7.708	2.450	0.220	40.222	0.190	-0.520	6.986	0.53	1.32
13	JS 20-64	8.144	2.320	-0.020	31.766	1.180	-0.570	6.544	1.35	0.86
14	JS 20-65	8.078	-2.060	2.800	35.282	0.530	82.480	7.068	-0.18	0.34
15	JS 20-69	8.414	-1.570	1.080	42.731	-0.610	64.370	7.199	-0.56	1.37
16	JS 20-70	8.397	2.010	-0.010	35.357	1.250	167.510	6.566	0.79	0.87
17	JS 20-71	8.526	3.290	1.390	40.244	1.650	173.190	9.054	2.52	8.10
18	JS 20-73	8.657	4.750	0.610	39.173	0.630	32.870	7.882	0.93	1.08
19	JS 20-74	7.441	-3.070	0.070	26.599	0.990	50.930	4.953	-0.02	-0.02
20	JS 20-75	7.099	0.020	3.440	32.141	1.090	50.350	6.249	0.19	3.10
21	JS 20-79	8.121	-0.840	0.160	37.029	1.610	10.410	8.101	0.74	0.19
22	JS 20-80	8.542	5.770	0.020	34.154	1.820	78.350	6.208	2.64	-0.01
23	JS 20-82	9.080	2.850	2.400	34.922	0.710	1.460	7.200	-0.45	14.45
24	JS 20-85	8.041	-0.630	-0.030	36.393	1.410	138.550	5.946	-0.07	0.03
25	JS 20-86	8.531	1.500	0.010	43.951	1.840	99.950	8.651	1.81	-0.01
26	JS20-87	7.717	-5.270	3.000	33.162	0.820	11.150	7.756	0.03	1.19
27	JS 20-88	7.898	0.090	0.040	35.874	1.370	1.700	6.772	0.76	0.04
28	JS 20-89	7.893	1.590	0.110	38.983	0.230	33.970	6.603	0.44	-0.04
29	JS 20-90	7.922	1.940	0.320	37.357	0.060	155.740	6.297	1.46	0.51
30	JS 20-91	7.803	2.000	0.010	42.228	0.930	45.030	7.117	1.26	-0.03
31	JS 20-92	7.040	1.650	0.320	33.547	-0.510	3.220	4.983	0.38	1.59
32	JS 20-93	8.230	1.670	-0.010	40.360	0.010	76.900	7.282	1.46	1.48
33	JS 20-94	8.777	-0.350	0.680	40.678	0.640	25.420	7.996	1.17	0.17
34	JS 20-95	8.346	4.500	1.300	35.809	1.230	110.770	6.631	2.15	1.39
35	JS 20-96	8.901	2.310	0.310	42.702	1.080	8.560	9.031	1.07	0.60
36	JS 20-98	8.200	0.130	3.040	37.559	0.730	162.470	7.401	0.47	10.62
37	JS 20-99	8.001	2.030	0.220	31.343	0.840	15.250	6.973	-0.04	0.38
38	RVS 2007-4	8.248	2.150	4.950	37.457	1.470	47.220	6.912	1.49	6.67
39	JSM 7	8.107	-1.210	0.040	33.717	2.020	99.030	4.713	1.18	6.28
40	JSM 20	6.568	1.630	-0.040	33.401	1.390	102.810	4.442	1.34	3.41
41	JSM 126	7.959	0.290	-0.040	33.028	0.970	2.870	6.069	1.42	3.98
42	JSM 127	8.421	-0.100	-0.040	40.787	0.650	42.360	8.259	-0.47	0.82
43	JSM 146	5.590	-0.250	0.070	27.241	1.390	76.550	4.026	1.16	0.57
44	JSM 175	8.239	-0.310	-0.030	37.856	1.700	11.580	6.913	1.14	0.80
45	JSM 207	7.892	-2.140	0.130	32.501	1.780	-0.010	4.893	1.47	1.17
46	JSM 230	8.047	-1.030	0.230	37.573	1.460	2.030	6.594	1.38	0.90
47	JSM 242	6.970	-0.390	0.580	34.534	1.580	6.650	4.916	0.52	0.02
48	JSM 271	7.891	0.480	-0.010	30.830	1.820	1.250	4.360	1.30	0.68
49	JSM 283	8.072	0.770	-0.040	38.099	1.770	39.880	7.019	1.90	7.15
50	JSM 302	8.910	0.380	-0.020	44.628	1.100	20.300	8.630	1.43	2.86
	Population Mean	8.035			36.402			6.653		

Table-6 : Soybean genotypes identified for stability and adaptability.

Traits	Stable over different environments (S_2di~0, bi~1)	Specific adaptability	
		Better environment (S_2di~0, bi>1)	Poor environment (S_2di~0, bi<1)
Vegetative stage (days)	JS 20-93, JS 20-53, JS 20-89, JS 20-98, JSM-7, JSM-20, JSM-127 and JSM 242	JS 95-60 and JSM 207	JS 20-69,JS 20-82, JS 20-50, JS 20-96, JS 20-59, JSM 302 and JSM 175
Reproductive stage (days)	JSM 230, JSM 7, JSM 207, JSM 20, JSM 126, JS 20-88, JS 20-53, JS 20-98, JS 20-69, JS 20-91, JS 20-94, JS 20-82, JS 20-29, JS 20-41, JS 20-95 and Bragg	JS 20-73 and JS 20-87	JSM 302, JSM 146, JS 20-96, JS 20-70 and JS 20-71
Plant height at (cm)	JS 20-79	JS 20-50, JS 20-53, JS 20-73	JS 93-05, JS 335, JS 97-52, Bragg and RVS 2007-4
Number of pod clusters plant1	JS 20-88, JS 20-70, JS 20-92, JS 20-64, JS 20-74, JS 20-95, JS 20-34, NRC 37, JS 93-05, JS 95-60, JSM 207, JSM 20, JSM 242, JSM 175, JSM 230, JSM 283, JSM 126, JSM 146, JSM 283, JSM 302 and Bragg	JS 20-90	JSM 302
Number of nodes plant-1	JS 20-50, JS 20-74, JS 20-80, JS 20-90, JS 20-93, JS 20-98, JS 95-60, JS 20-34, JS 93-05, JS 20-96, JS 335, JS 20-69, JSM 127, JSM 242, JSM 207, JSM 271, JSM 20 and RVS 2007-4	JS 20-92, JS 20-65, JS 20-71, JS 20-85 and JS 20-87	JS 20-64, JS 20-59, JS 20-99, JS 20-86, JS 97-52, JS 20-79, JS 20-91, JS 20-73, JSM 230, JSM 175, JSM 302, JSM 146, JSM 7, JSM 126, NRC 37 and Bragg
Number of branches plant^{-1}	JS 20-75, JS 20-93, JS 20-69, JS 20-59, JS 20-96, JS 20-88, JS 93-05, JSM 242, JSM 7 and JSM 127	JS 20-99, JS 20-71, JS 20-53, JS 20-65, JS 20-64, JS 20-98, JS 20-34, JS 20-74, JS 20-75, JS 20-94, JS 20-50, JSM 302, JSM 283, JSM 175, NRC 37 and RVS 2007-4	JS 20-87, JS 20-29, JS 97-52, JS 20-79, JS 20-86, JS 20-41, JS 20-70, JS 20-94 and JSM 302
Number of pods plant^{-1}	JS 93-05, JS 95-60, JS 20-34, JS 20-65, JS 20-79, JS 20-82, JS 20-85, JS 20-93, JS 20-95, JSM 20 and JSM 126	JS 97-52, NRC-37, Bragg, JS 20-69, JS 20-70, JS 20-71, JS 20-86, JS 20-87, JS 20-96, JS 20-98, JS 20-99, RVS 2007-4, JSM 7, JSM 127, JSM 230, JSM 241, JSM 271, JSM 283 and JSM 302	JS 20-29, JS 20-41, JS 20-50, JS 20-53, JS 20-59, JS 20-64, JS 20-73, JS 20-75, JS 20-90 and JS 20-94
Number of seeds plant^{-1}	JS 20-90	JS 20-88, JS 20-70, JS 20-92, JS 20-64, JS 20-74, JS 20-95, JS 20-34, NRC 37, JS 93-05, JS 95-60, JSM 207, JSM 20, JSM 242, JSM 175, JSM 230, JSM 283, JSM 126, JSM 146, JSM 283, JSM 302 and Bragg	JSM 302
Biological yield plant1 (g)	JS 97-52, NRC 37 and JSM 302	JS 20-71, JS 20-86, JS 20-70, JS 20-50 and RVS 2007-4	JS 20-64 and JS 20-96
100 seed weight (g)	JS 20-99, JS 20-88, JS 20-90, JS 20-89, JS 20-87, JS 93-05, JS 20-65, JS 20-75, JS 335, JSM 126, JSM 207, JSM 271, JSM 242 and JSM 146	JS 20-41, JS 20-50, JS 20-96, JS 20-73, JS 20-80, JS 20-86, JS 20-64, JS 95-60, JSM 302, JSM 127, JSM 175, JSM 283, JSM 230 and NRC 37	JS 20-53, JS 20-94, JS 20-79, JS 20-85, JSM 302, JSM 127, JSM 175, JSM 7, JSM 283 and JSM 230
Harvest index (%)	JS 20-69, JS 20-91, JS 20-93, JS 20-94, JS 20-73, JS 20-89, JS 20-98, JS 20-90, JS 97-52 and JSM 127	JS 20-86, JS 20-50, JS 20-53, JS 20-71, JS 20-79, JSM 302, JSM 175, JSM 230, JSM 283, NRC 37 and RVS 2007-4	JS 20-59 and JS 20-41
Seed yield plant^{-1} (g)	JS 20-89, JS 20-70, JS 20-85, JS 20-34, JS 20-74, JS 93-05, JS 95-60 and JSM 241	JS 20-96, JS 20-86, JS 20-94, JS 20-41, JS 20-91 and JSM 175	JS 20-88, JS 20-99, JS 20-65, and JSM 127

important yield contributing traits found suitable over different environments. Whereas JS 20-64, JS 20-73, JS 20-94, JS 20-96, JSM 302, Bragg were found suitable for poor environments. JS 20-53, JS 20-41, JS 20-98, RVS 2007-4, JSM 283 were found stable for favorable environment (Table.6). Identified genotypes for stability and adaptability are presented in Table-6. (7, 12) concluded that genotype JS 335 is suitable for poor environment.

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