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Stability analysis over different environments for seed yield and its contributing traits in sesame (*Sesamum indicum* L.)

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Abstract
The present investigation was undertaken to assess the genotype x environment interaction in sesame by evaluating fourty five genotypes in four different environments created by sowing at two locations (Anand and Vaso) in two different seasons (summer and *Kharif*) of the year 2019. Pooled analysis of variance across four environments revealed the significant difference among tested genotypes. Variances due to environments were highly significant for all the characters suggested that environments were effective in influencing the performance of genotypes. Mean squares due to G × E interaction were significant for branches per plant, capsules per plant, seeds per capsule, seed yield per plant and oil content revealed that genotypes reacted differentially to different environmental conditions. Both linear and non-linear components were important for genotypic and environmental interactions. The genotype Rama showed desirable mean value of seed yield and average responsive to all kind of environments. Genotypes AT-334, GT-2, PKVNT-11, AKT-101 and Tillottama denoted high mean values of seed yield and high responsive to favourable environments. While, genotypes AT-288, AT-314, AT-390, GT-1, GT-5, GT-10 and TC-66 had high mean values of seed yield and performed well in poor environmental conditions signifying that the stable genotypes can be directly used for different suitable environmental conditions.

Keywords: Stability analysis, regression coefficient, environmental indices, seed yield, sesame

Introduction
Sesame is one of the most ancient and important oilseed crops, majorly cultivated in tropical and sub-tropical regions of the world. Sesame is grown for its seeds and oil. It had earned a poetic label "Queen of Oilseeds" as its oil and protein are of very high in quality. Genetic and environmental factors influence the oil content and fatty acids profile in sesame (Carlsson *et al*., 2008) [6]. In sesame oil, oleic (C18:1) and linoleic (C18:2) fatty acids are the predominant fatty acids and make up more than 80% of the total fatty acids. The high levels of unsaturated (UFA) and polyunsaturated fatty acids (PUFAs) improve the quality of the oil for human consumption. Late maturing cultivars are reported to have higher oil content than early cultivars (Yermanos *et al*., 1972) [21] and the indeterminate cultivars accumulated more oil than determinate ones. The variability in environment namely location effect, seasonal fluctuations and their interaction highly influence the performance of genotypes in relation to yield potential. So, the quantum jump in yield can be realized by breeding a genotype performing the best over all the environments. Seed yield being a complex quantitative character is highly influenced by the environment. Thus, the study of genotype x environment interaction using suitable biometrical techniques would lead to successful identification of stable genotypes which would either be released for commercial cultivation or to be used in future breeding programme.

Materials and methods
To assess the stability performance of forty five sesame genotypes (Table 1) for seed yield and its contributing traits an experiment was conducted in randomized complete block design with three replications. The experiment was carried out in four environments (two locations and two seasons) i.e. Summer - 2019 at Anand (E_1), Summer – 2019 at Vaso (E_2), *Kharif* – 2019 at Anand (E_3) and *Kharif* – 2019 at Vaso (E_4). Each entry was accommodated in a single row of 3 m length with a spacing of 30 x 10 cm.

The recommended agronomical practices and plant protection measures were followed for the successful raising of the crop. The observations were recorded on five randomly selected plants in each entry and replication and their mean values were used for the statistical analysis. Twelve characters *viz.*, days to 50% flowering, days to maturity, plant height (cm), branches per plant, capsules per plant, capsule length (cm), seeds per capsule, test weight (g), seed yield per plant (g), harvest index (%), oil content (%) and protein content (%) were studied. The Stability analysis was dond using the linear regression model suggested by Eberhart and Russell (1966) [7].

Table 1: List of sesame genotypes selected for the study

Sr. No.	Genotype Name	source	Sr. No.	Genotype Name	Source
1	AT-253	ARS, Amreli, Gujarat	24	TC-289	AICRP, Tikamgadh, Madhya Pradesh
2	AT-283	ARS, Amreli, Gujarat	25	MT-75	ARS, Amreli, Gujarat
3	AT-288	ARS, Amreli, Gujarat	26	Bhachav-7	ARS, Amreli, Gujarat
4	AT-306	ARS, Amreli, Gujarat	27	TMV-4	TNAU, Tamil Nadu
5	AT-307	ARS, Amreli, Gujarat	28	PKVNT-11	AICRP, Nagpur, Maharashtra
6	AT-308	ARS, Amreli, Gujarat	29	RT-46	ARS, Mandore, Rajsthan
7	AT-314	ARS, Amreli, Gujarat	30	RT-103	ARS, Mandore, Rajsthan
8	AT-315	ARS, Amreli, Gujarat	31	RT-358	ARS, Mandore, Rajsthan
9	AT-324	ARS, Amreli, Gujarat	32	RT-369	ARS, Mandore, Rajsthan
10	AT-334	ARS, Amreli, Gujarat	33	Tilak	TNAU, Tamil Nadu
11	AT-390	ARS, Amreli, Gujarat	34	RSS-106	ARS, Amreli, Gujarat
12	NIC-17274	AICRP, Nagpur, Maharashtra	35	SSM	ARS, Amreli, Gujarat
13	Borda-2	ARS, Amreli, Gujarat	36	PATAN-64	ARS, Amreli, Gujarat
14	Khadakala-4	ARS, Amreli, Gujarat	37	ABT-33	ARS, Amreli, Gujarat
15	GT-1	ARS, Amreli, Gujarat	38	Nanabhamodara	ARS, Amreli, Gujarat
16	GT-2	ARS, Amreli, Gujarat	39	Keriya-7	ARS, Amreli, Gujarat
17	GT-3	ARS, Amreli, Gujarat	40	AKT-64	PDKV, Akola, Maharashtra
18	GT-4	ARS, Amreli, Gujarat	41	AKT-101	PDKV, Akola, Maharashtra
19	GT-5	ARS, Amreli, Gujarat	42	SVPR	TNAU, Tamil Nadu
20	GT-10	ARS, Amreli, Gujarat	43	Tillottama	ORS, Berhampore, West Bengal
21	TC-25	AICRP, Tikamgadh, Madhya Pradesh	44	Kayamkulam	KAU, Kerala
22	TC-66	AICRP, Tikamgadh, Madhya Pradesh	45	Rama	ORS, Berhampore, West Bengal
23	TC-125	AICRP, Tikamgadh, Madhya Pradesh			

Result and Discussion

Analysis of variance over four environments for stability of different characters has been presented in Table 2. Mean squares due to genotypes over pooled environments were highly significant for all the characters indicated the presence of substantial variation in the present material. Variances due to environments were highly significant for all the characters suggested that environments were effective in influencing the performance of genotypes. Mean squares due to G × E interaction were significant for branches per plant, capsules per plant, seeds per capsule, seed yield per plant and oil content only while for days to 50% flowering, days to maturity, plant height, capsule length, test weight, harvest index and protein content they were non significant. The existence of significant genotype × environment interaction for yield, yield components and quality traits in sesame crop were also reported by Solanki and Gupta (2000) [16], Upadhyay *et al.* (2000) [19], Solanki *et al.* (2001) [17], Kumar *et al.* (2008) [9], Bhandarkar and Kumar (2010) [5], Kumar *et al.* (2013) [8], Mirza *et al.* (2013) [12], Mali *et al.* (2015) [10], Misganaw *et al.* (2015) [13], Misganaw *et al.* (2017) [14], Belay *et al.* (2018) [3], Beniwal *et al.* (2019) [4], Ali (2020 and Singh and Shukla (2022) [1, 15].

Mean squares due to E + (G × E) were observed to be non significant. Highly significant estimates of mean squares due to environment (linear) for all the characters revealed differences over the environments were real. The variance due to G × E interaction was further partitioned into components of G × E (linear) and G × E (non-linear) i.e. pooled deviation. Mean square due to G × E (linear) interaction were highly significant for all the traits except branches per plant, capsules per plant, capsule length, seeds per capsule, harvest index and protein content. Mean square due to pooled deviations (non-linear portion) were highly significant for all the characters under study except days to 50% flowering, days to maturity, plant height, capsule length and test weight indicating the importance of non-linear component in the genotype x environment interaction. As the G × E interaction were significant for branches per plant, capsules per plant, seeds per capsule, seed yield per plant and oil content only their results pertaining to stability performance have been discussed and presented in Table 3.

For branches per plant among the genotypes varied between 2.40 (RT-103) to 9.50 (TMV-4) with a mean value of 4.09. The regression coefficient values were significant for five genotypes. The deviations from regression values were significant for fourteen genotypes. The genotypes Tillottama (7.25) and Rama (8.38) exhibited high mean values with equal to unity of regression coefficient (bi = 1) and non-significant deviation from regression, indicating that these genotypes were stable and well perform under all environments. The genotypes NIC-17274, GT-10, TC-25, AKT-64, SVPR and Kayamkulam denoted high mean value of concerned trait with regression coefficient more than unity (bi > 1) and non-significant deviation from regression were considered to be stable for favorable environmental condition.

The variation exhibited for capsules per plant ranged from 29.9 (RT-103) to 72.2 (TMV-4) with a mean value of 44.96. The regression coefficient values were significant for forty genotypes. The deviations from regression values were significant for fourteen genotypes. The two sesame genotypes TC-125 and SVPR recorded high mean values of the trait against grand mean value with equal to unity of regression coefficient (bi = 1) and non-significant deviation from regression, denoted that these genotypes were considered as stable and adapted to all kind of environments. On the other hand, genotypes MT-75, PKVNT-11, RSS-106, Nanabhamodara, Kayamkulam and Rama showed high mean value with regression coefficient more than unity (bi > 1) and non-significant deviation from regression, therefore, this genotypes could be stable and perform well under favorable environmental conditions. Whereas, genotypes GT-10 and TC-25 had high mean value with less than unit regression (bi < 1) and non-significant deviation from zero which indicated these genotypes were stable and high responsive to poor environments.

Mean values of seeds per capsule ranged from 44.23 (RT-103) to 67.97 (TMV-4) with grand mean value of 54.85. The regression coefficient were significant for fourteen genotypes. The deviation from regression values were significant for sixteen genotypes. The genotypes AT-253, AT-306, AT-307, AT-315, AT-324, AT-334, Khadakala-4, TMV-4 and PKVNT-11 could perform well under favourable environmental condition as they exhibited high mean with greater than unit regression (bi > 1) and the least deviation from regressions. The genotypes AT-283, AT-288 and TC-25 and Keriya-7 were considered to be stable for poor environmental conditions as they recorded high mean with less than unit regression (bi < 1) and non-significant deviations from regression. None of the genotype showed non-significant regression coefficient nearing unity (bi = 1).

The variation exhibited for seed yield per plant ranged from 3.39 (RT-103) to 10.07 g (TMV-4) with a mean value of 5.95 g. Analysis of stability for seed yield per plant indicated a total of fifteen genotypes had significant deviation from regression, and only two genotypes had non-significant regression coefficient. The genotype Rama recorded high mean value against population mean, unit of regression coefficient (bi = 1) and non-significant deviation from regression. Therefore this genotype was considered as stable and average responsive to all kind of environments. The genotypes AT-334, GT-2, PKVNT-11, AKT-101 and Tillottama could perform well under favorable environmental conditions as they exhibited high mean with more than unit regression (bi > 1) and non-significant deviation from regression. On the other hand, genotype AT-288, AT-314, AT-390, GT-1, GT-5, GT-10 and TC-66 showed high mean with less than unit regression (bi < 1) and non-significant deviation from regression, could perform well even under poor environmental conditions.

Mean values of oil content ranged from 45.96 (AT-308) to 51.94% (AT-324) across environments with a grand mean value of 48.36%. A total of twenty one genotypes denoted significant deviation from regression which considered as unstable for concerned trait while remaining twenty four genotypes expressed non-significant S^2di values which were considered stable. For this trait, the genotype NIC-17274, TC-66, GT-4, ABT-33 and Kariya-7 were considered to be stable for favorable environmental conditions as they exhibited high mean with greater than unit regression (bi > 1) and non-significant deviation from regression value. The genotypes GT-1, GT-3, GT-10, TMV-4 and Rama denoted high mean values of the trait with less than unit regression (bi < 1) and non-significant deviation from regression, denoted stable and appropriate for poor environment conditions.

Environmental index reveals the suitability of an environment. Estimates of environmental indices (Table 4) indicated that environment E_3 were positive for all the characters except oil content and protein content. Contrarily, it was negative for environment E_1 and E_2 for most of the studied traits except oil content and protein content. Environment E_4 was found to be most suitable for days to 50% flowering (4.68), days to maturity (4.07), plant height (1.78), capsule length (0.13), seeds per capsule (0.25), test weight (0.02), seed yield per plant (0.17) and harvest index (0.25). These results indicated the superiority of environment E_3 and inferiority of environment E_1 and E_2. For seed yield per plant, index of environment E_3 was the highest (1.68) while the lowest was for the index of environment E_2 (-1.43), indicating that environment E_3 was favorable for seed yield per plant.

Table 2: Analysis of variance for phenotypic stability of seed yield and yield contributing traits in sesame

Sr. No.	Characters	Mean sum of squares							
		Genotypes (G)	Environments (E)	Genotypes x environments (G x E)	E+(G x E)	Environments (linear)	G x E (linear)	Pooled deviation	Pooled error
	df	44	3	132	135	1	44	90	352
1	Days to 50% flowering	30.27 **	4239.42 **	4.84	98.95	12718.14 **	9.37 **	2.52	5.94
2	Days to maturity	24.73**	3509.81**	3.84	81.75	10529.97*	6.96**	2.22	7.19
3	Plant height	348.14**	8186.55**	31.92	213.13	24559.50**	55.52**	19.67	67.40
4	Branches per plant	9.73**	0.45*	0.15*	0.15	1.36**	0.06	0.19**	0.11
5	Capsules per plant	371.23**	2550.10**	19.36*	75.60	7650.05**	18.74	19.23**	14.77
6	Capsule length	0.49**	0.77**	0.02	0.04	2.32**	0.03	0.02	0.06
7	Seeds per capsule	124.08**	76.72**	14.90*	16.27	229.62**	15.81	14.12**	11.37
8	Test weight	0.17**	0.07*	0.02	0.02	0.21**	0.03**	0.01	0.06
9	Seed yield per plant	8.32*	78.29**	0.50**	2.23	234.88**	0.69*	0.04**	0.22
10	Harvest index	18.25**	93.01**	0.78	2.83	279.17**	0.99	0.67**	0.84
11	Oil content	5.86**	36.97**	0.30**	1.12	110.97**	0.65**	0.12**	0.04
12	Protein content	5.32**	21.24**	0.07	0.54	63.74**	0.03	0.09**	0.07

*, ** Significant at 5 and 1% levels, respectively

Table 3: Stability parameters of different genotypes for seed yield and yield components over environments in sesame

Sr. No.	Genotypes	Branches per plant			Capsules per plant			Seeds per capsule			Seed yield per plant (g)			Oil content (%)		
		Mean	bi	S^2di	Mean	bi	S^2di	Mean	bi	S^2di	Mean	bi	S^2di	Mean	bi	S^2di
1	AT-253	3.57	1.61	0.10	37.97	1.13**	3.93	60.35	2.6	7.16	4.98	1.16**	1.10	47.28	1.53**++	0.00
2	AT-283	4.00	0.66	0.15	66.50	1.16**	20.48*	55.13	-0.19	1.53	5.90	1.41**	0.67**	48.35	1.45**+	0.07**
3	AT-288	3.13	-0.49	0.10	41.80	1.27**	4.77	60.97	0.11	3.07	6.63	0.5**++	-0.05	47.69	1.14**	0.00
4	AT-306	3.73	1.32	0.28**	35.73	1.05**	-3.35	58.22	-1.22	3.70	6.02	0.56*	0.27*	48.60	0.75**	0.11**
5	AT-307	3.73	0.44	0.05	40.88	0.86**	-1.08	59.27	2.83	4.53	6.91	1.12*	1.58**	47.21	1.55**++	0.00
6	AT-308	3.20	2.57	0.20**	33.73	1.07**	4.23	51.28	-0.43	2.57	4.78	0.73**	0.09	45.96	1.14**	0.32*
7	AT-314	4.33	-0.28	0.44**	50.80	0.92*	28.81**	58.72	1.36	29.00**	6.69	0.89**	0.19	47.49	0.92*	0.52**
8	AT-315	3.40	1.64	0.05	47.25	1.44	89.51**	59.75	2.92**++	-2.32	7.41	1.02**	0.71**	47.22	1.62**++	-0.01
9	AT-324	3.77	-0.17	0.25**	43.12	1.36	116.18**	57.48	-1.24+	2.76	6.49	1.34**	1.10**	51.94	0.78**	0.07**
10	AT-334	2.88	1.82*	-0.01	37.60	1.05**	-1.33	66.57	3.33**++	-2.19	7.04	1.28**+	0.01	49.02	0.32	0.31**
11	AT-390	4.03	-1.5	0.41**	41.18	1.05**	1.07	52.08	4.81**++	-3.47	6.06	0.98**	-0.06	47.98	0.62*	0.13**
12	NIC-17274	4.27	1.2	0.17	41.97	0.4+	9.34	66.82	1.45	14.70*	5.77	0.86**	0.37**	50.14	1.55**++	0.00
13	Borda-2	3.83	0.68	-0.03	51.52	0.83	52.26**	49.57	4.55**++	-3.41	6.05	1.22*	1.75**	49.69	0.99*	0.50**
14	Khadakala-4	3.50	-0.27	0.50**	40.77	0.95**	7.84	59.53	2.15	4.51	3.96	0.72**++	-0.03	48.84	0.26++	0.11**
15	GT-1	3.75	-0.78*++	-0.04	44.28	0.5**++	-0.40	49.13	2.33*	2.28	6.84	0.2**++	-0.05	48.88	0.19++	0.02
16	GT-2	2.95	0.73	0.14	41.48	0.61**++	-1.87	52.38	2.66**++	-3.52	7.05	1.18**+	-0.04	48.36	0.25++	0.11**
17	GT-3	2.68	2.88*	0.02	36.73	0.48**++	-3.25	53.80	1.65	3.62	7.07	0.39+	0.26*	48.94	0.15**++	-0.01
18	GT-4	3.17	-0.12	0.03	41.70	1.25**	17.11*	51.38	1.39	12.89*	5.89	1.39**++	-0.04	48.37	1.34**++	0.00
19	GT-5	3.88	-1.9	0.10	37.10	0.42**++	-3.68	52.25	2.95	10.33	6.19	0.11*++	-0.07	48.14	0.43**++	-0.02
20	GT-10	6.50	1.65	-0.01	49.53	0.8**+	-3.79	47.72	-1.25**++	-3.68	7.47	0.57**+	0.16	49.98	0.59**++	-0.01
21	TC-25	4.37	3.7	-0.01	47.78	0.85**	3.91	58.10	-0.37+	-2.08	5.15	0.8**	0.04	48.62	0.73**	0.14**
22	TC-66	3.52	-0.17	0.33**	54.42	0.98	44.07**	56.75	3.66	17.83**	6.53	0.96**	0.09	48.78	2.1**++	0.03
23	TC-125	3.58	1.11	0.00	64.93	1.07**	19.58	59.82	-0.18	34.06**	4.94	1.5**	0.28*	47.37	1.37**	0.22**
24	TC-289	3.15	0.74	-0.01	36.12	0.83*	21.56*	46.97	2.26	10.80	4.37	1.18**	0.18	47.53	0.74**++	-0.01
25	MT-75	3.43	-0.67	0.13*	47.77	1.25**	7.02	50.98	-1.74+	3.12	4.40	1.09**	0.06	47.54	2.12**++	0.19**
26	Bhachav-7	3.60	0.25	0.01	32.65	0.77**+	-3.16	50.25	1.96	13.72*	4.45	0.95**	0.03	46.98	1.06**	0.03
27	TMV-4	9.50	2.81	0.37**	72.17	1.46**	17.71*	67.97	2.17**++	-3.06	10.07	1.47**	1.26**	50.18	0.21**++	-0.01
28	PKVNT-11	3.73	1.87	0.05	47.97	1.18**	11.54	61.33	-1.32*++	-1.68	6.49	1.29**+	0.00	47.28	1.77**+	0.22**
29	RT-46	3.33	1.27	0.05	33.85	0.74*	17.81*	50.30	1.85	23.56**	5.04	1.63**+	0.26	47.88	0.74**++	-0.01
30	RT-103	2.40	2.38**	-0.01	29.90	1.04**	-3.23	44.23	-1.24	4.86	3.39	0.58**++	0.05	47.37	0.79*	0.22**
31	RT-358	3.38	1.62	0.15*	42.23	1.26**++	-4.71	51.98	-0.21	35.25**	4.38	1.14**	0.13	46.78	1.22**++	-0.01
32	RT-369	3.75	-2.68	1.70**	35.22	0.87**+	-4.27	53.55	0.38	13.77*	5.06	1.3**++	-0.05	47.85	0.71**++	-0.01
33	Tilak	3.85	1.51	0.03	43.37	1.15**	1.43	48.75	-0.3	11.08	4.88	1.05**	0.08	48.27	1.68**++	0.00
34	RSS-106	3.37	4.48	0.45**	47.60	1.12**+	-4.40	55.97	1.27	28.24**	5.13	0.7**++	-0.07	49.60	0.62	0.31**
35	SSM	2.78	1.66	0.05	40.23	0.65**++	-4.89	47.52	-2.83++	6.96	3.69	0.5**	0.13	46.94	1.49**	0.00
36	Patan-64	2.87	-0.66	0.00	34.12	1.18**	30.72**	49.63	1.48	27.35**	5.16	1.45**++	0.02	47.90	0.9**	0.26**
37	ABT-33	3.55	2.46	0.08	41.80	0.75**	65.26**	57.77	-0.35	17.25*	6.92	1.25*	2.00**	49.14	1.33**+	0.05
38	Nanabhamodara	4.03	1.98	0.23**	56.17	1.13**++	-1.20	54.77	0.54	43.63**	5.15	1.19**	0.65**	49.77	1.03*	0.42**
39	Keriya-7	3.10	1.22	0.48**	37.92	1.77**++	1.95	62.38	0.9	-0.25	6.04	0.44	0.37**	50.97	1.26**++	0.00
40	AKT-64	5.03	1.17	-0.01	38.98	1.44**++	-1.00	52.78	1.39	8.66	5.15	0.92	1.87**	47.61	1.2**	0.03
41	AKT-101	3.13	1.26	0.04	56.03	1.63**	51.67**	47.08	3.26**++	-1.11	5.18	1.22**++	-0.02	48.24	0.5	0.36**
42	SVPR	6.55	2.2	0.05	51.72	1.03**	3.40	53.98	0.77	41.57**	5.73	1.09**	0.08	47.25	1.57**++	-0.01
43	Tillottama	7.25	1.08	-0.01	49.32	0.21	33.44**	53.93	-0.57	29.12**	6.01	1.2**	0.17	47.40	1.21**	0.14**
44	Kayamkulam	7.98	1.64**++	-0.04	54.90	1.37**	7.87	51.92	-0.45	2.91	9.46	1.47**	0.28*	49.09	0.72**	0.13**
45	Rama	8.38	1.07	-0.03	64.62	1.7**++	-4.84	57.32	-0.02	15.58*	9.73	1.04**	0.10	49.93	0.35++	0.09
Genotype Mean		4.09			44.96			54.85			5.95			48.36		
S.Em. ±		0.25	2.52		2.53	0.37		2.17	1.67		0.37	0.28		0.20	0.23	

*, ** Significant at 5 and 1% levels, respectively when H0: b=0
+, ++ Significant at 5 and 1% levels, respectively when H0: b=1

Table 4: Environmental indices of different characters of sesame genotypes under four environments

Environments	Days to 50% flowering	Days to maturity	Plant height	Branches per plant	Capsules per plant	Capsule length	Seeds per capsule	Test weight	Seed yield per plant	Harvest index	Oil content	Protein content
E_1	-5.23	-3.33	-4.93	0.00	-2.27	-0.07	-0.35	0.02	-0.43	-0.25	0.92	0.66
E_2	-10.53	-10.53	-14.43	0.00	-7.80	-0.18	-1.55	-0.08	-1.43	-1.75	0.63	0.59
E_3	11.08	9.77	17.58	0.10	10.21	0.13	1.65	0.02	1.68	1.75	-0.58	-0.41
E_4	4.68	4.07	1.78	-0.10	-0.15	0.13	0.25	0.02	0.17	0.25	-0.98	-0.83

Note: Environment 1: Anand Summer – 2019
Environment 2: Vaso Summer – 2019
Environment 3: Anand *Kharif* - 2019
Environment 4: Vaso *Kharif* -2019

Conclusion

Based on stability analysis, the present investigation identified stable sesame genotypes for seed yield per plant, its component characters and quality traits under different environmental conditions. Genotype Rama was found to be average responsive to all kind of environments. Genotypes AT-334, GT-2, PKVNT-11, AKT-101 and Tillottama were responsive to favourable environments while, genotypes AT-288, AT-314, AT-390, GT-1, GT-5, GT-10 and TC-66 performed well in poor environmental conditions. Thus, it was concluded that the stable genotypes can be directly used for different suitable environmental conditions.

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