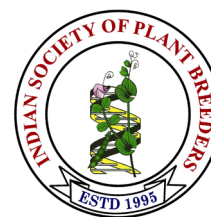


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Research Article

Stability analysis for yield and its component traits in sesame (*Sesamum indicum* L.) genotypes

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Abstract

The current study was performed with 22 sesame genotypes including three checks to identify stable genotypes for different yield and yield attributing traits across three locations (BAC, Sabour; BPSAC, Purnea and ARI, Patna) during two years 2024 and 2025 using Eberhart and Russell model. The stability parameter revealed that the genotypes GT-6, Smarak, Sabour Til-1, BRT-08, BRT-09, BRT-10-1, BRT-12, Suprava and GT-10 had higher seed yield/plant as compared to the population mean. The genotypes GJT-5, GT-6, RT-125, RT-346, AT-384, Sabour Til-1, BRT-08, BRT-09, BRT-10-1 and BRT-12 registered regression coefficient >1. The genotypes GT-4, JLS-120, TLT-07, Smarak, YLM-146, VS-19-045, OSM-79-19-3, Suprava, Kalika, TKG-22, GT-10 and JTS-8 recorded regression coefficient <1. Three genotypes namely BRT-08, BRT-09 and BRT-10-1 recorded non-significant deviation from regression. Thus, in favorable environment genotypes BRT-08, BRT-09 and BRT-10-1 were stable. The genotypes BRT-08, BRT-09 and BRT-10-1, being stable and high yielding genotypes, can be recommended for cultivation under diverse agro-ecological zones.

Keywords: Sesame, stability, Eberhart and Russel

INTRODUCTION

Sesame (*Sesamum indicum* L.), a significant oilseed crop of the family *Pedaliaceae*. It is a *autogamous crop* with a chromosome number of $2n = 2x = 26$ (Prathyusha *et al.*, 2021). With over 3,000 years of cultivation history, sesame has been utilized by humans for more than 6,000 years as a source of seeds, leaves, and oil for dietary and culinary purposes (Namiki *et al.*, 2007). Sesame seeds are rich in oil (48–55%), protein (20–28%), carbohydrates (14–16%), and fiber (6–8%), along with essential minerals, vitamins, phytosterols, tocopherols, lignans, and other bioactive compounds that contribute to human health by mitigating aging, atherosclerosis, cardiovascular diseases, and degenerative conditions such as cancer (Pathak *et al.*, 2014). Additionally, sesame oil is notably

stable and resistant to rancidity under high-temperature conditions (Fukuda *et al.*, 1985). Global demand for sesame products has surged due to population growth, urbanization, and evolving dietary habits (Myint *et al.*, 2020). Despite its economic importance, sesame production faces numerous constraints including genotype $\times$ environment interaction ($G \times E$), limited availability of high-yielding and locally adapted cultivars, capsule shattering, low seed retention, and susceptibility to various abiotic and biotic stresses, compounded by inadequate adoption of modern production and post-harvest technologies (Dinkar *et al.*, 2024, Singh *et al.*, 2024, Rodge *et al.*, 2003 and Sinha, 2023). The interaction between genotype and environment is a major

concern in plant breeding, as it affects the expression of quantitative traits and impedes genotype characterization and selection efficiency. $G \times E$ interaction is a key factor determining phenotypic stability and adaptability, as genotypes respond differently to environmental variations (Kim *et al.*, 2014). Identifying phenotypically stable genotypes with consistent performance across diverse environments is essential for breeding programs aimed at enhancing sesame productivity. Agricultural systems, especially in India with its diverse agro-climatic zones, are increasingly affected by climate change. These environmental shifts necessitate changes in sowing time and crop management practices to mitigate stress and maintain yield stability. To accurately assess $G \times E$ interaction, multi-environment trials (METs) are indispensable (Mustapha *et al.*, 2014). In the estimation of phenotypic stability, regression analysis has proved to be a valuable technique for assessing the response of various genotypes under changing environmental conditions. Hence, the present study was undertaken with a view to identify highly stable genotypes for yield and its attributing traits over different environments.

MATERIALS AND METHODS

The current investigation was performed on 22 sesame genotypes including two national checks (GT-10 and TKG-22) and one zonal check (JTS-08) (Table 1) to achieve the proposed objective at three different location (i) BAC Sabour; (ii) BPSAC Purnea and (iii) ARI Patna during summer season of 2024 and 2025, forming six

environments (Table 2). Randomized block design was adopted with three replications at each location. Morphological data on seed yield per plant, stem length to first capsule, length of capsule, width of capsule, number of seeds per capsule, biological yield per plant, number of capsules per plant and days to maturity were recorded on five randomly selected plants per genotype per replication and their mean were used for statistical analysis.

The mean data was used to assess the stability of genotypes based on Eberhart and Russel (1996) model. According to this model those genotypes that having mean performance higher than overall mean, regression coefficient close to unity and non-significant deviation from regression were considered as the stable genotypes.

RESULTS AND DISCUSSION

The pooled ANOVA (Table 3) revealed that mean squares due to genotypes were significant for all the characters studied, indicating the presence of considerable genetic variability among the genotypes. Environments also exhibited significant variability for all traits, and the environment (linear) component was significant, confirming the distinct nature of the environments. The genotype $\times$ environment (linear) interaction was significant for all characters except number of capsules per plant, number of seeds per capsule, and days to maturity. The pooled deviation was highly significant for all the traits, highlighting the role of non-linear interactions. Similar findings were reported by Kumar *et al.* (2008),

Table 1. List of genotypes

S. No.	Genotype Name	S. No.	Genotype Name
1	GT-4	12	BRT-09
2	GJT-5	13	BRT-10-1
3	GT-6	14	BRT-12
4	RT-125	15	YLM-146
5	RT-346	16	VS-19-045
6	JLS-120	17	OSM-79-19-3
7	TLT-07	18	Suprava
8	Smarak	19	Kalika
9	AT- 384	20	TKG-22 (NC)
10	Sabour Til-1	21	GT-10 (NC)
11	BRT-08	22	JTS-8 (ZC)

Table 2. List of environments with sowing time and year

S. No	Environments	Location	Sowing month with year	Latitude	Longitude	Altitude
1	E1	BAC, Sabour	March (2024)	25.2376° N	87.0507° E	46m MSL
2	E2	BPSAC, Purnea	March (2024)	25.8147° N	87.5173° E	36m MSL
3	E3	ARI, Patna	March (2024)	25.5833° N	85.1320° E	52m MSL
4	E4	BAC, Sabour	March (2025)	25.2376° N	87.0507° E	46m MSL
5	E5	BPSAC, Purnea	March (2025)	25.8147° N	87.5173° E	36m MSL
6	E6	ARI, Patna	March (2025)	25.5833° N	85.1320° E	52m MSL

Table 3. Pooled ANOVA for stability (Eberhart & Russell model)

Source of Variations	Rep within Environment	Genotypes	Env.+ (Gen. x Env.)	Environments	Gen. x Env.	Environments (Lin.)	Gen. x Env. (Lin.)	Pooled Deviation	Pooled Error	Total
Mean Sum of Squares										
df	12	21	110	5	105	1	21	88	252	131
SLFC	12.28	3758.47**	12009.26**	7994.00**	4015.25	7994.00**	1222.29*	2792.96**	360.74	15767.72
NCP	47.97	6764.62**	17816.07*	6334.51**	11481.56	6334.51**	2273.38	9208.18**	1284.81	24580.69
LC	0.16	4.40**	6.84	0.58*	6.27	0.58**	2.12**	4.15**	1.74	11.24
WC	0.00	0.24**	0.34**	0.15**	0.19**	0.15**	0.12**	0.07**	0.08	0.58
NSPC	14.75	1157.25**	1204.58	24.81	1179.77	24.81	259.72	920.05**	670.47	2361.83
BYPP	171.80	20981.78**	23559.66*	2400.48**	21159.18*	2400.48**	8991.03**	12168.15**	1920.51	44541.44
DM	1.12	2161.54**	4425.13**	2126.27**	2298.85	2126.27**	484.51	1814.34**	37.60	6586.67
SYPP	0.2	56.86**	84.30*	10.34**	73.97*	10.34**	30.49**	43.48**	9.43	141.16

*Significant at 5%, **Significant at 1%, SLFC- Stem length to first capsule, NCP-Number of seeds per capsule, LC- Length of capsule, WC- Width of capsule, NSPC- Number of seeds per capsule, BYPP- Biological yield per plant, DM-Days to maturity and SYPP- Seed yield/plant

Sumalatha *et al.* (2008), Mekonnen and Mohammed (2009), Suvarna *et al.* (2011), Patel *et al.* (2022), Khan *et al.* (2023), and Shaikh *et al.* (2024).

Stability parameters for individual traits : The stability parameters for seed yield per plant (**Table 4**) ranged from 5.61 g (YLM-146) to 8.21 g (Sabour Til-1), with a

Table 4. Estimates of stability parameters for stem length to first capsule and number of capsules per plant

S. No.	Genotype	Seed Yield/plant			Stem length to first capsule		
		bi	βi	S ² Di	bi	βi	S ² Di
1	GT-4	6.65	-0.10	1.244**	42.08	1.03	32.397**
2	GJT-5	6.27	1.52	0.425**	42.78	1.23	25.350**
3	GT-6	7.25	1.24	0.121**	35.58	0.66	1.870
4	RT-125	6.61	5.117*	0.509**	39.65	0.98	73.304**
5	RT-346	6.49	2.98	0.737**	40.86	0.98	71.514**
6	JLS-120	5.91	0.83	0.281**	45.76	1.43	13.734**
7	TLT-07	5.89	0.91	0.609**	44.50	1.07	52.786**
8	Smarak	6.77	-0.65	0.821**	35.40	0.63	5.118**
9	AT-384	6.17	1.74	0.764**	36.76	0.47	20.199**
10	Sabour Til- 1	8.21	3.554*	0.246**	26.88	1.15	24.387**
11	BRT-08	7.29	2.028**	-0.02	32.48	1.395	1.46
12	BRT-09	7.45	2.616*	0.03	32.23	1.30	15.468**
13	BRT-10-1	7.38	2.578**	0.00	32.68	1.37	15.920**
14	BRT-12	7.38	2.01	0.122**	32.84	1.23	9.183**
15	YLM-146	5.61	0.24	0.542**	45.77	1.54	36.761**
16	VS-19-045	6.27	0.51	0.265**	43.55	1.614*	15.263**
17	OSM-79-19-3	6.63	-1.36	1.678**	36.57	0.42	102.231**
18	Suprava	8.08	-0.852*	0.149**	26.76	0.44	15.356**
19	Kalika	6.46	0.86	0.503**	38.36	1.34	31.648**
20	TKG-22 (NC)	6.74	-1.17	0.256**	38.11	0.73	36.019**
21	GT-10 (NC)	6.77	-1.72	0.455**	35.78	0.26	48.380**
22	JTS-8 (ZC)	6.60	-0.88	0.335**	36.93	0.74	10.809**
Mean		6.767	1		37.377	1	
SEm±		0.3143	1.0254		2.519	0.2955	

* Significance at 5 % level, ** Significance at 1 % level

population mean of 6.767 g. The check GT-10, along with eight genotypes, namely, GT-6, Smarak, Sabour Til-1, BRT-08, BRT-09, BRT-10-1, BRT-12, and Suprava, recorded higher seed yield per plant compared to the population mean, which is considered desirable. None of the checks exhibited regression coefficients greater than 1; however, ten genotypes—GJT-5, GT-6, RT-125, RT-346, AT-384, Sabour Til-1, BRT-08, BRT-09, BRT-10-1, and BRT-12—showed regression coefficients above 1. In contrast, the check GT-10, TKG-22, and JTS-8, along with nine genotypes, namely, GT-4, JLS-120, TLT-07, Smarak, YLM-146, VS-19-045, OSM-79-19-3, Suprava, and Kalika, had regression coefficients less than 1. All the genotypes exhibited significant deviation from regression, except BRT-08, BRT-09, and BRT-10-1. Based on the stability model, none of the checks were found to be stable in favorable environments; however, three genotypes—BRT-08, BRT-09, and BRT-10-1—were stable under favorable conditions. No genotypes were found to be stable in unfavorable environments. Similar observations on seed yield per plant in sesame were reported by Kumaresan *et al.* (2010), Mali *et al.* (2015), Raikwar (2016), and Shaikh *et al.* (2024).

For yield attributing characters like for stem length to the first capsule (**Table 4**) based on the stability model, none of the checks were found to be stable in favorable environments; however, genotype BRT-08 exhibited stability under favorable environments. Conversely, GT-6 demonstrated stability in unfavorable environments. Similar findings regarding stem length to the first capsule in sesame have been reported by Kumaresan *et al.* (2010), Mali *et al.* (2015), Raikwar (2016), and Shaikh *et al.* (2024). For capsule length (**Table 5**) none of the checks were found to be stable in favorable environments; however, three genotypes—BRT-09, BRT-10-1, and BRT-12—exhibited stability under favorable environments. Conversely, GT-6 was found to be stable under unfavorable environments. Analogous findings on capsule length in sesame were reported by Kumaresan *et al.* (2010), Mali *et al.* (2015), Raikwar (2016), and Shaikh *et al.* (2024). For capsule width (**Table 5**), the check JTS-8 was stable under favorable environments, while none of the other genotypes showed such stability. However, four genotypes—JLS-120, TLT-07, YLM-146, and Kalika—were found to be stable under unfavorable environments. Similar observations on capsule width in sesame were

Table 5. Estimates of stability parameters for length of capsule and width of capsule

S. No.	Genotype	Length of Capsule			Width of Capsule		
		bi	βi	S ² Di	bi	βi	S ² Di
1	GT-4	2.66	-1.10	0.130**	0.55	1.77	0.001**
2	GJT-5	2.49	-0.68	0.032**	0.59	2.010*	0.000*
3	GT-6	2.70	0.42	0.00	0.60	1.82	0.001**
4	RT-125	2.52	2.57	0.029**	0.57	1.845**	0.00
5	RT-346	2.49	1.82	0.091**	0.60	1.79	0.001**
6	JLS-120	2.46	1.22	0.01	0.65	-0.883**	0.00
7	TLT-07	2.42	1.08	0.060**	0.67	-0.255**	0.00
8	Smarak	2.61	0.03	0.056**	0.54	0.94	0.00
9	AT-384	2.46	2.85	0.052**	0.63	0.04	0.002**
10	Sabour Til- 1	3.03	3.658*	0.011*	0.54	0.33	0.002**
11	BRT-08	2.85	2.79	0.019**	0.54	-0.19	0.001**
12	BRT-09	2.83	3.215**	0.00	0.53	1.39	0.00
13	BRT-10-1	2.87	3.573*	0.01	0.52	1.50	0.00
14	BRT-12	2.89	3.594**	0.00	0.53	0.81	0.00
15	YLM-146	2.48	-2.18	0.123**	0.62	-0.183*	0.00
16	VS-19-045	2.51	-2.471*	0.027**	0.55	2.02	0.001**
17	OSM-79-19-3	2.70	-0.49	0.055**	0.54	1.733**	0.00
18	Suprava	3.05	1.77	0.042**	0.54	1.53	0.001**
19	Kalika	2.63	2.24	0.0183**	0.64	-0.147*	0.00
20	TKG-22 (NC)	2.67	0.33	0.0548***	0.57	1.38	0.00
21	GT-10 (NC)	2.63	-1.85	0.0526***	0.56	1.25	0.00
22	JTS-8 (ZC)	2.69	-0.39	0.0135*	0.58	1.50	0.00
Mean		2.665	1		0.575	1	
SEm±		0.097	1.3406		0.0129	0.3447	

* Significance at 5 % level, ** Significance at 1 % level

Table 6. Estimates of stability parameters for number of seeds per capsule and biological yield per plant

S. No.	Genotype	Number of seeds per capsule			Biological yield per plant		
		bi	β_i	S ² Di	bi	β_i	S ² Di
1	GT-4	60.31	-8.092*	7.878 **	78.56	2.88	372.102**
2	GJT-5	56.89	2.23	6.465**	69.76	1.43	82.816**
3	GT-6	60.11	0.07	6.620 **	87.29	0.52	53.714**
4	RT-125	57.92	5.98	23.384***	77.29	-2.13	292.760**
5	RT-346	57.58	3.55	17.405**	71.11	-2.81	207.397**
6	JLS-120	56.11	0.02	1.57	70.31	2.11	178.757**
7	TLT-07	56.47	4.46	8.785**	59.08	1.809*	0.13
8	Smarak	59.72	-1.54	11.609**	81.10	2.49	1.265
9	AT-384	58.25	1.58	16.545**	68.06	2.63	318.633**
10	Sabour Til- 1	67.11	3.17	5.4013*	106.67	-1.483**	15.686*
11	BRT-08	62.61	2.80	4.533*	95.62	-0.18	63.766**
12	BRT-09	63.00	1.71	6.209**	95.57	-1.145**	9.59
13	BRT-10-1	62.19	4.65	1.26	95.90	-1.342*	34.640**
14	BRT-12	62.31	2.86	0.04	94.97	-0.73	56.024**
15	YLM-146	54.81	-0.40	-0.20	66.62	0.43	116.481**
16	VS-19-045	57.69	-0.54	5.384*	72.40	0.81	32.368**
17	OSM-79-19-3	59.56	3.82	22.262**	76.74	2.38	341.225**
18	Suprava	65.14	-1.31	10.357**	103.47	2.09	97.469**
19	Kalika	58.53	4.551*	-1.40	73.05	0.96	164.331**
20	TKG-22 (NC)	62.03	-1.628*	-1.63	78.66	3.34	103.216**
21	GT-10 (NC)	60.69	-2.55	11.437**	75.34	4.310*	91.645**
22	JTS-8 (ZC)	59.69	-3.40	9.008**	74.00	3.61	108.371**
Mean		59.942	1		80.527	1	
SEm±		1.446	3.0448		5.258	1.1257	

* Significance at 5 % level, ** Significance at 1 % level

reported by Kumaresan *et al.* (2010), Mali *et al.* (2015), Raikwar (2016), and Shaikh *et al.* (2024).

For number of seeds per capsule (**Table 6**) none of the checks were stable under favorable environments; however, two genotypes—BRT-10-1 and BRT-12—were stable under favorable environments. Conversely, the check TKG-22 was found to be stable under unfavorable environments, while no other genotype showed such stability. Similar findings regarding the number of seeds per capsule in sesame were reported by Kumaresan *et al.* (2010), Mali *et al.* (2015), and Shaikh *et al.* (2024). For biological yield per plant (**Table 6**) none of the checks were stable in favorable environments; however, one genotype—Smarak—was found to be stable under favorable environment. Conversely, BRT-09 exhibited stability under unfavorable environments. Similar findings related to biological yield per plant in sesame were reported by Kumaresan *et al.* (2010), Mali *et al.* (2015), and Shaikh *et al.* (2024). For number of capsules per plant (**Table 7**) none of the checks were found to be stable under favorable environments; however, genotype BRT-10-1 exhibited stability under such favorable environments. In contrast, Smarak was stable under unfavorable environments.

Similar results regarding the number of capsules per plant in sesame have been reported by Kumaresan *et al.* (2010), Mali *et al.* (2015), Raikwar (2016), and Shaikh *et al.* (2024). For days to maturity (**Table 7**) none of the checks were stable in favorable environments, but one genotype—BRT-09—exhibited stability under favorable environments. No genotype was found to be stable in unfavorable environments. Similar findings on days to maturity in sesame were reported by Kumaresan *et al.* (2010), Mali *et al.* (2015), and Shaikh *et al.* (2024).

Considering the above findings, the genotypes BRT-08, BRT-09, and BRT-10-1 exhibited superior stability across diverse environmental conditions. Their consistent performance, particularly for seed yield per plant, indicates a high degree of genetic stability and potential for wide adaptation. These genotypes are therefore strong candidates for inclusion in hybridization programs aimed in combining stability traits and enhancing genetic resilience. Incorporating these genotypes in breeding strategies may facilitate the development of high-yielding, stable cultivars with broad environmental adaptability, thereby contributing to sustainable sesame production across variable agro-climatic zones.

Table 7. Estimates of stability parameters for days to maturity and seed yield/plant

S. No.	Genotype	Number of capsules per plant			Days to Maturity		
		bi	β_i	S ² Di	bi	β_i	S ² Di
1	GT-4	60.50	0.55	270.710**	91.03	1.77	20.913**
2	GJT-5	54.67	1.28	101.610**	92.31	1.40	14.078**
3	GT-6	67.72	0.97	16.426**	89.03	0.45	28.196**
4	RT-125	61.47	1.55	235.659**	87.17	0.94	70.772**
5	RT-346	58.42	1.68	171.164**	91.14	0.47	54.356**
6	JLS-120	54.69	1.03	20.304**	92.64	0.81	9.039**
7	TLT-07	59.17	0.44	148.672**	92.42	0.36	10.889**
8	Smarak	65.08	0.276**	-1.35	87.94	0.59	51.043**
9	AT-384	56.08	1.28	77.065**	94.06	1.99	23.323**
10	Sabour Til- 1	77.81	1.57	77.908**	80.72	0.79	8.949**
11	BRT-08	69.83	1.61	9.502*	84.94	1.46	4.572**
12	BRT-09	71.08	1.63	23.837**	84.86	1.14	1.446
13	BRT-10-1	70.14	1.70	1.36	85.58	1.22	10.979**
14	BRT-12	70.94	1.46	38.545**	84.72	0.97	7.137**
15	YLM-146	54.61	1.02	75.341**	93.33	0.60	3.101**
16	VS-19-045	55.36	1.36	16.048**	91.19	1.35	2.913**
17	OSM-79-19-3	60.28	0.40	227.339**	95.17	1.91	44.797**
18	Suprava	78.28	0.13	37.580**	82.56	0.40	25.487**
19	Kalika	56.69	1.44	212.740**	88.67	1.15	19.022**
20	TKG-22 (NC)	62.31	0.24	251.090**	93.67	0.74	8.472**
21	GT-10 (NC)	60.56	-0.45	81.687**	92.36	0.57	14.530**
22	JTS-8 (ZC)	59.97	0.84	65.060**	93.81	0.92	9.344**
Mean		62.985	1		89.514	1	
SEm±		4.574	0.6028		2.0306	0.4619	

* Significance at 5 % level, ** Significance at 1 % level

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