Indian J. Genet. Plant Breed., (2023); 83(4): 605-608
https://doi.org/10.31742/ISGPB.83.4.17
ISSN: 0975-6906
www.isgpb.org

SHORT RESEARCH ARTICLE

Genotype x environment interaction in hybrids and parents of Sesame (*Sesamum indicum* L.)

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Abstract

Pooled analysis of variance for phenotypic stability of 56 F_1 hybrids along with 8 parents using 8 x 8 diallel mating design for seed yield, its components and oil content in sesame were assessed in four different environments in the Marathwada region of Maharashtra. Genotype x Environment (G x E) interaction was significant for all the characters except for days to maturity. The environment (linear) component of variance was significant for all the characters except oil content against pooled error, indicating the presence of macro-environmental differences under all four environments. The mean sum of squares due to G x E (linear) was significant for days to 50% flowering, days to maturity, plant height, number of capsules per plant, length of capsule, number of seeds per capsule, 1000 seed weight and seed yield per plant indicating variation in the performance of genotypes due to the regression of genotypes on the environment. The mean sums of squares due to pooled deviation (non-linear) were significant for most characters, suggesting the role of unpredictable causes affecting stability. However, the magnitude of non-linear components was lower for most of the characters than G x E (linear) variance. Among the crosses, TBS-10 x V-29, TBS-7 x TBS-12 and R-20 x R-09 were the most stable for seed yield per plant over a wide range of environments. These stable crosses also showed stable performance for most of the yield attributing traits and oil content.

Keywords: Sesame, G x E interaction, stability, regression coefficient, deviation from regression

Sesame (*Sesamum indicum* L.) is an ancient oil seed crop and known as "Queen of oilseed". Being the fourth most important oilseed crop in Indian agriculture, it is widely cultivated in the states of Uttar Pradesh, Rajasthan, Odisha, Gujarat, Andhra Pradesh, Tamil Nadu, Karnataka, West Bengal, Bihar and Assam. In Maharashtra, during 2020-21, sesame was cultivated in an area of 1.3 lakh ha with a production of 0.28 lakh tones and productivity of 217 kg/ha (Anon., 2021). This crop is generally cultivated as a sole or mixed crop during the *kharif,* semi-*rabi* and summer seasons. Sesame's productivity is very low compared to other oilseed crops; hence, it is necessary to raise the productivity and, thereby, total oilseed production to meet the country's edible oil requirements. The prerequisite for crop improvement programme is the availability of useful genetic diversity (Saljooghianpour and Javadzadeh 2018). The estimates of combining ability based on a single season may not reveal the real merits of the parents because of the Genotype x Environment interaction. Genotype and its interaction with the prevailing environment is the basic factor determining the final yield. The G x E interaction is particularly important in the expression of quantitative characters controlled by polygenic systems and greatly modified by environmental influences. Thus, the experiment must be repeated over different environments to have unbiased estimates of various genetic components. The stability analysis was attempted to identify adaptable genotypes over a wide range of environments, develop

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How to cite this article: Rathod, S.T., Gite, V.K., Prakash, J., Jambhulkar, S.J., Ghodke, M. 2023. Genotype x Environment interaction in hybrids and parents of Sesame (*Sesamum indicum* L.). Indian J. Genet. Plant Breed., **83**(4): 605-608.

Source of support: Nil

Conflict of interest: None.

Received: July 2023 **Revised:** Sept. 2023 **Accepted:** Oct. 2023

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phenotypically stable high potential cultivars, and predict varietal responses under changing environments.

The experimental material consisted of eight diverse parents, namely, TBS-3, TBS-7, TBS-10, TBS-12, TBS-105, R-09, R-20 and V-29 and their 56 F_1's with three checks viz., AKT-101, JLT-408 and GT-2 were grown in randomized block design with two replications in four environments consisting two locations in each season viz., Parbhani (E_1), Ambajogai (E_2) in summer 2020 while Parbhani (E_3) and Ambajogai (E_4) during *kharif* 2020. The 56 F_1 crosses were made at Oilseed Research Station, Latur, during *kharif* 2019 by using an 8 x 8 diallel mating design, including reciprocals. Five competitive plants were selected randomly to record observations on days to 50% flowering, days to maturity, plant height, number of branches per plant, number of capsules per plant, length of capsule, number of seeds per capsule, 1000-seed weight, seed yield per plant and oil content. The nature and extent of G x E interactions and the performance of genotypes depending on environmental interactions were studied using the model proposed by Eberhart and Rusell (1966).

Analysis of variance

Pooled analysis of variance for phenotypic stability of seed yield, its components and oil content is presented in Table 1. Genotype x Environment (G x E) interaction was significant for all the characters except days to maturity, indicating differential response of genotypes in different environments. Considering interactions of genotypes with environments, as the environmental plus genotypes x environments were significant for all the characters except number of branches per plant and oil content. The environment (linear) component of variance was significant for all the characters studied except oil content against pooled error, indicating that macro-environmental differences were present under all four environments studied. The mean sum of squares due to G x E (linear) was significant for days to 50% flowering, days to maturity, plant height, number of capsules per plant, length of capsule, number of seeds per capsule, 1000 seed weight and seed yield per plant indicated that the variation in the performance of genotypes was due to the regression of genotypes on the environment and hence predictable. Many researchers found the preference of linear components for seed yield earlier. The mean sums of squares due to pooled deviation (non-linear) were significant for most of the characters, suggesting the role of unpredictable causes affecting stability. However, the magnitude of non-linear components was lower for most of the characters than G x E (linear) variance.The stability parameters for yield, its contributing traits, and oil content are presented in Table 2.

Stability for different parameters

For days to 50% flowering the crosses TBS-12 x TBS-7, R-09 x TBS-105, R-20 x TBS-105, V-29 x TBS-105 and R-09 x TBS-3 had lower mean than their respective means, regression

Table 1. ANOVA for stability for seed yield per plant, its components and oil content

Source of variation	d. f.	Days to 50% flowering	Days to maturity	Plant height (cm)	No of branches/ plant	Number of capsules/plant	Length of capsule (cm)	Number of seeds/ capsule	1000 seed weight (g)	Seed yield/ plant (g)	Oil content (%)
Genotypes (G)	66	5.60**++	26.95**++	289.84**++	0.21**++	585.54**++	0.22**++	156.84**++	0.52**++	40.43**++	61.35**++
Environments (E)	3	235.75**++	81.10**++	11736.44**++	0.59**++	19586.93**++	0.08**++	51.63**++	0.83**++	32.19**++	3.81++
G x E	198	2.92**++	3.53	167.29**++	0.09++	233.70**++	0.01**++	6.16*++	0.03**++	5.98++	3.57++
E+ (G x E)	201	6.40**	4.68**	339.97**	0.09	522.55**	0.01**	6.84**	0.05**	6.37*	-3.58
E (Linear)	1	707.27**++	243.30**++	35209.32**++	1.77**++	58760.77**++	0.25**++	154.91**++	2.50**++	96.58**++	11.44++
G x E (Linear)	66	6.87**++	4.64*	311.99**++	0.09++	415.28**++	0.02**++	9.16**++	0.11**++	8.61**++	3.52++
Pooled deviations	134	0.94	2.92	93.53**	0.08**	140.77**	0.003	4.59**	0.000	4.59**	3.55**
Pooled error	264	1.91	5.34	30.40	0.02	12.12	0.004	3.002	0.001	0.64	0.25
Total	267	6.20	10.19	327.58	0.12	538.12	0.06	43.91	0.16	14.79	17.86

* Significant at 5% level and ** significant at 1% level when tested against pooled deviation
+ Significant at 5% level and ++ significant at 1% level when tested against pooled error

Table 2. Stability of Parents and hybrids for yield and yield contributing traits in sesame

Stability parameters	Parents/ hybrids	* Days to 50% flowering	* Days to maturity	Plant Height	Number of branches/plant	Number of capsules/plant
High Mean bi = 1 S^2di = 0/ or minimum	P	--	V-29	TBS-10	--	--
	H	TBS-12 x TBS-7, R-09 x TBS-105, R-20 x TBS-105, V-29 x TBS-105 and R-09 x TBS-3	TBS-3 x R-20, V-29 x R-20, TBS-10 x V-29, TBS-7 x V-29, TBS-7 x R-09, TBS-7 x TBS-105	TBS-105 x TBS-10, R-09 x V-29, R-09 x TBS-10, R-20 x TBS-7	R-09 x V-29, V-29 x TBS-3	TBS-105 x V-29, TBS-10 x V-29, R-20 x TBS-7, V-29 x TBS-105
Stability Parameters	**Parents/ hybrids**	**Length of capsule**	**Number of seeds/ capsule**	**1000-Seed weight**	**Seed yield/plant**	**Oil content**
High Mean bi = 1 S^2di = 0/ or minimum	P	TBS-3	TBS-3	TBS-12, TBS-3	--	--
	H	TBS-3 x TBS-7, TBS-7 x TBS-105, TBS-105 x R-20, R-09 x R-20 and R-20 x TBS-7	TBS-10 x R-20, TBS-10 x TBS-105, R-09 x R-20	R-20 x TBS-7, V-29 x TBS-7, R-09 x TBS-7, TBS-105 x V-29, TBS-105 x TBS-12, TBS-7 x TBS-10, TBS-12 x V-29, TBS-12 x TBS-10	TBS-10 x V-29, TBS-7 x TBS-12, R-20 x R-09	TBS-3 x TBS-12

* Low mean is desirable for days to 50% flowering and days to maturity. P= Parents and H= hybrids

coefficient equivalent to unity and S^2d_i equivalent to zero exhibiting average stability and adaptability therefore identified as most stable and desirable for earliness. The present findings support the findings of Raikwar (2016). The parent TBS-10 had a mean higher than the general mean, a regression coefficient near to unity and S^2d_i equivalent to zero which showed average stability, hence the most stable for tallness. The crosses TBS-105 x TBS-10, R-09 x V-29, R-09 x TBS-10 and R-20 x TBS-7 had mean higher than general mean, b_i equivalent to unity and S^2d_i equivalent to zero, manifested average stability, therefore most stable for tallness. Similar results have been reported earlier in sesame but a different sets of materials at different environments have been used in each study (Mirza et al. 2013; Raikwar 2016). Considering mean performance and stability parameters for number of branches per plant two crosses namely R-09 x V-29 and V-29 x TBS-3 possessed a higher mean than general mean, regression coefficient near to unity and S^2d_i equivalent to zero, hence average stable. Highly stable genotypes have been identified.

The crosses TBS-105 x V-29, TBS-10 x V-29, R-20 x TBS-7 and V-29 x TBS-105 had a mean higher than the general mean, regression coefficient near to unity and S^2d_i equivalent to zero, manifested average stability, therefore most stable for the character number of capsules per plant. This trait's Average stability was also reported by Kumaresan and Nadarajan (2010) and Raikwar (2016). The parent TBS-3 had a mean equivalent to general mean but a regression coefficient equal to unity and S^2d_i equivalent to zero disclosed average stability and therefore had higher adaptability for length of the capsule. On the basis of higher mean than general mean, b_i=1 and $S^2d_i \approx 0$, the crosses TBS-3 x TBS-7, TBS-7 x TBS-105, TBS-105 x R-20, R-09 x R-20 and R-20 x TBS-7 were found most stable for this character, however the length of capsule showed average stability. The parent TBS-3 had a higher mean than the general mean, b_i=1 and S^2d_i equivalent to zero, disclosed average stability and therefore had higher adaptability for number of seeds per capsule. The crosses TBS-10 x R-20, TBS-10 x TBS-105 and R-09 x R-20 had higher mean than general mean. The regression coefficient near unity and S^2d_i equivalent to zero revealed average stability. Therefore most stable for seeds per capsule and desirable.

The parent TBS-12 and TBS-3 had higher mean than general mean coupled with regression coefficient equivalent to unity and S2di ≈0, which were considered to have average stability. The crosses R-20 x TBS-7, V-29 x TBS-7, R-09 x TBS-7, TBS-105 x V-29, TBS-105 x TBS-12, TBS-7 x TBS-10, TBS-12 x V-29 and TBS-12 x TBS-10 had high mean than general mean coupled with regression coefficient equivalent to unity and non-linear component equivalent to zero, exhibited average stability. Average stability for 1000-seed weight in sesame has been earlier reported by Kumaresan and Nadarajan (2010). The crosses TBS-10 x V-29, TBS-7 x TBS-12 and R-20 x R-09 had a higher mean than the general mean, regression coefficient (b_i=1) near to unity and S^2d_i equivalent to zero, exhibited average stability. Therefore, most stable for seed yield per plant. Sixty four sesame genotypes comprising 48 hybrids and 16 parents of sesame were evaluated for stability parameters for days to 50% flowering, number of branches, numbers of capsules and single plant yield over three environments by Kumaresani and Nadarajan (2005) and reported three parents two hybrids stable for yield and other parameters. The only cross TBS-3 x TBS-12 had a higher mean than the general mean, regression coefficient near to unity and S2di equivalent to zero, indicating average oil content stability. Raikwar (2016) also reported some parents with high oil content. The stable genotypes with respect to different parameters have also been reported earlier by several researchers. Therefore, these genotypes involved in the hybrids displaying superior combinations can be recommended for varied environments to exploit their high yield potential.

Authors' contribution

Conceptualization of research (STR, MG); Design of the experiments (STR, MG); Contribution of experimental experiments (STR, MG, SJJ, JP, VKG); Execution of field/lab experiments and data collection (STR, MG, VKG); Analysis of data and interpretation (STR, MG); Preparation of manuscript (STR, SJJ, MG).

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