Research Article

Genotype x environment interactions for seed yield and its components in sesame (*Sesame indicum* L.).

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Abstract
A study was conducted to analyze the genotype by environment (GxE) interaction effect on yield and its components in sesame grown in three environments by using AMMI analysis. The mean square were significant for genotypes, environments, GxE interaction for the characters viz., number of capsules, 1000 seed weight and single plant yield. The genotypes namely PSR 2007 x Co1, Si 42 x Co 1, Si 42 x VRI 1, AHT 123 x VRI 1, B 203 x SVPR 1 and YLM 4030 x SVPR 1 recorded high mean but low interaction effect which are desirable for releasing as stable hybrids. The genotypes OMT 30 x VRI 1, OMT 30 x SVPR 1 and DPI 1424 x VRI 1 exhibited high interaction effect and are suitable for specific environments
Key words:
Genotypes, GxE interaction, AMMI analysis

Introduction

Sesame (*Sesamum indicum* L.) known as gingelly, til or beniseed is a most important and ancient oilseed crop. It is rich in oil (53.53%) and protein (26.25%). Sesame oil is noted for its stability and quality. As sesame is a short day plant and sensitive to photo, thermo and moisture stress, the yield is not stable and vary widely. The variability in environments viz., location effect, seasonal influence and their interactions highly influences the performance of genotypes in relation to yield potential.

The statistical analysis applied to yield data is only analysis of variance (ANOVA) which is based on linear model with additive main effects and interactions. Though it identifies the GxE interaction, it provides no insight into the particular patterns of genotypes or environment that give rise to GxE interaction. Generally in yield data all three sources of variance namely genotype, main effect, the environment main effect and GxE interaction are statistically significant and agronomically important (Kempton, 1984). Models like principal component analysis (PCA) and linear regression are also not adequate in treating the complex data structure of yield trial effectively (Gollob, 1968; Mandel 1971; Kempton 1984; Zobel *et al*., 1988). The AMMI model given by Zobel *et al*., (1988) incorporates both additive and multiplicative effects. Hence, it is very essential to find out suitable genotypes having high stability over wide range of environments.

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Material and Methods

Fourty eight hybrids along with 16 parents were evaluated in three environments *viz*., winter, summer and kharif seasons at Agricultural College and Research Institute, Madurai, Tamil Nadu. The genotypes were sown in a randomized block design replicated thrice with a spacing of 30x30cm. Twenty plants were maintained for each genotype in a replication out of which ten competitive plants were randomly selected for recording biometrical observation. The package of practices recommended for sesame was normally and timely followed.

The AMMI statistical model is a hybrid model. It makes use of standard ANOVA procedures to separate the additive variance from the multiplicative variance (genotype x environment interaction) and then uses a multiplicative procedure (Principal

Component Analysis – PCA) to extract the pattern from the GxE portion of the ANOVA analysis. The result is the least square analysis which with further graphical representation of the numerical results (Biplot analysis), often allows a straightforward interpretation of the underlying causes of GxE. The mathematical statement of the hybrid model is

$$Y_{ij}^{N} = \mu + g_i + e_j + \Sigma\lambda_k Y_{ik}\alpha_{jk} + \Sigma_{ij}$$

Where Y_{ij} - yield of i^{th} genotype in the j^{th} environment

μ - grand mean

g_i e_j - genotype and environment deviations from the grand mean

λ_k – eigen value of the principal component analysis (PCA) axis k

Y_{ik} & α_{jk} - genotype and environment principal components scores for axis k

N- is the number of principal components in the AMMI model.

Σ_{ij} – residual term

The AMMI biplot is developed by placing both genotype and environment values on the X- axis and the respective PCA axis eigen vector on the Y- axis.

Results and Discussion

The analysis of variance had split the total variance into additive main effects and multiplicative interactions. The mean squares were significant for genotypes, environments, GxE interaction and PCA 1 for all the characters taken for the study (Table 1). The results of AMMI analysis can also be easily comprehended with help of AMMI biplot as presented in Fig. 1 to 3. The mean performance and PCA 1 scores for both the genotypes and environment used to construct the biplot (Fig. 1 to 3) are presented in Table 2. In a AMMI biplot presentation, when a genotype and environment have the same sign on PCA I axis, their interaction is positive and if different their interaction is negative. If a genotype or an environment has a PCA I score of nearly zero it has small interaction effect and are considered as stable over wide range of environment. However, the genotypes with high mean performance with large PCA I scores are considered as having specific adaptability to the environments.

Number of capsules

The environments E_1 and E_2 exhibited similar main effects and differed in interaction effects. E_3 was most favourable for the genotype OMT 30 x SVPR 1, since positive interaction was observed between them. Four genotypes viz., OMT 30 x SVPR 1, OMT 30 x VRI 1, DPI 1424 x TMV 3 and DPI 1424 x SVPR 1 expressed high mean and large interaction effects. These genotypes are suitable for specific environments. The hybrids namely PSR 2977 x Co 1, Si 3315/11 x SVPR 1, Si 3315/11 x TMV 3, YLM 4030 x TMV 3, B 203 x SVPR 1, Si 3216 x SVPR 1, PSR 2007 x SVPR 1, TNAU 28 x VRI 1, DPI 1424 x Co 1, Si 42 x SVPR 1 and TNAU 28 x Co 1 expressed high mean and low interaction effects that are generally adaptable to all environments (Fig. 1).

1000 seed weight

All the three environments showed similar main effects but had variation in the interaction effects. The genotypes TNAU 28 x TMV 3, YLM 4030 x SVPR 1 are favourable in E_1 and PSR 2007 x Co1 in E_2. The environment E_2 had positive interaction with most of the genotypes as evidenced from having high scores. The genotypes with desirable mean and low interaction effect were Si 42 x TMV 3, B 203 x SVPR 1, PSR 2977 x Co 1, AHT 123 x Co1, PSR 2007 x TMV 3, AHT 123 x VRI 1, Si 3216 x TMV 3, DPI 1424 x VRI 1, Si 3315/11 x TMV 3, B 203 x TMV 3 and TNAU 28 x VRI 1 which are having wide general adaptability. The genotypes viz., PSR 2007 x Co 1, Si 3315/11 x VRI 1 and Si 3216 x TMV 3 which exhibited high mean and large interaction effects are suitable to specific environments (Fig. 2)

Single plant yield

The environments E_1, E_2 and E_3 had same main effects but their interactions highly varied. Synthesizing of hybrids in E_1 will be possible due to low interaction effects whereas E_3 was highly interactive having high interaction effect. The genotypes TN 8467, Si 42 x TMV 3, Si 3216 x Co 1, AHT 123 x VRI 1, Si X 42 x VRI 1, YLM 4030 x SVPR 1, B 203 x SVPR 1, Si 3315/11 x VRI 1 and TN 8467 x Co 1 had high mean value with low interaction. Hence, these genotypes shall be regarded as stable. OMT 30 x VRI 1, OMT 30 x SVPR 1, DPI 1424 x TMV 3 and DPI 1424 x VRI 1 were found to have high interaction effect and can be suited only in specific environments (Fig. 3)

In the present study, a genotype stable for one character was not found to be stable for most of the other characters. This is in accordance with earlier findings of Rathnasamy and Jegathesan (1982). The cross B 203 x SVPR 1 was found to be stable for all the three characters. Therefore this hybrid can be recommended for varied environments to exploit their yield potential.

References

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Table 1. Pooled AMMI analysis of variance for sesame yield and its components over different environments

Sources of variation	df	Mean squares		
		No. of capsules	1000 seed weight	Single plant yield
Traits	191	371.13*	0.17*	12.00*
Genotypes	63	469.50*	0.23*	17.38*
Environments	2	10149.08*	0.06*	107.79*
GxE interaction	126	166.74*	0.14*	7.89*
PCA 1	64	265.64*	0.19*	10.54*
Error	384	0.53	0.00	0.29

Table 2. Mean and PCA I values for sesame yield and its components in AMMI analysis.

S. No	Genotypes	No. of capsules		1000 seed weight		Single plant yield	
		Mean	PCA1	Mean	PCA1	Mean	PCA1
1	AHT 123	64.11	-0.77	2.15	0.07	9.45	0.21
2	TNAU 28	80.97	1.40	2.05	-0.08	12.46	-0.23
3	TN 8467	87.51	-1.32	2.01	-0.08	13.43	-0.22
4	PSR 2977	64.44	-0.33	1.88	-0.06	10.30	0.76
5	YLM 4030	57.48	-0.45	1.99	-0.07	9.56	0.00
6	OMT 30	79.89	0.99	2.10	-0.11	12.95	0.44
7	DPI 1424	77.74	0.76	2.02	-0.09	10.53	0.74
8	PSR 2007	74.90	-0.37	1.93	-0.09	10.08	0.10
9	B 203	73.60	0.48	2.21	0.00	11.87	0.17
10	Si 42	66.67	0.36	2.18	0.00	9.38	0.06
11	Si 3216	62.33	0.28	1.70	-0.07	9.39	0.10
12	Si 3315/11	76.94	-0.78	2.01	-0.04	9.93	0.22
13	Co 1	90.12	0.57	2.04	-0.01	12.81	-0.38
14	TMV 3	85.32	0.02	2.06	-0.07	11.69	0.33
15	VRI 1	81.54	0.70	2.03	-0.06	11.00	0.76
16	SVPR 1	80.52	1.03	1.95	-0.04	11.97	0.53
17	AHT 123 x Co 1	102.76	1.13	2.50	0.05	14.41	-0.88
18	AHT 123 x TMV 3	87.36	-2.01	2.23	0.19	13.13	-0.58
19	AHT 123 x VRI 1	90.38	-2.50	2.56	0.10	12.62	0.04
20	AHT 123 x SVPR 1	93.50	1.26	2.10	-0.42	13.19	-0.53
21	TNAU 28x Co 1	115.83	0.11	2.45	0.34	17.29	-0.69
22	TNAU 28x TMV 3	90.16	-1.74	2.37	-0.38	13.05	-0.41

Table 2. Contd...

S. No	Genotypes	No. of capsules		1000 seed weight		Single plant yield	
		Mean	PCA1	Mean	PCA1	Mean	PCA1
23	TNAU 28x VRI 1	97.49	0.59	3.34	0.03	16.64	-0.74
24	TNAU 28x SVPR 1	80.83	0.48	2.20	-0.12	15.80	-0.94
25	TN 8467x Co 1	118.86	0.68	2.44	0.00	17.68	-0.51
26	TN 8467x TMV 3	95.63	-0.84	2.48	0.15	14.12	-0.60
27	TN 8467x VRI 1	90.87	-1.44	2.05	-0.16	15.08	-0.52
28	TN 8467x SVPR 1	92.57	1.76	1.98	-0.04	12.95	0.15
29	PSR 2977x Co 1	90.72	-0.16	2.38	0.00	10.17	0.18
30	PSR 2977x TMV 3	82.53	-1.55	2.45	0.31	13.53	0.92
31	PSR 2977x VRI 1	95.78	0.96	2.41	0.34	10.68	0.48
32	PSR 2977x SVPR 1	73.36	0.01	2.02	-0.19	15.07	0.65
33	YLM 4030x Co 1	90.26	0.32	2.21	-0.41	14.14	-0.87
34	YLM 4030x TMV 3	96.54	-0.50	2.54	0.32	11.42	-0.48
35	YLM 4030x VRI 1	95.38	-1.16	2.53	0.11	11.02	0.43
36	YLM 4030x SVPR 1	83.69	-1.66	2.43	0.00	13.60	0.01
37	OMT 30x Co 1	110.23	1.29	2.54	0.28	14.54	-0.99
38	OMT 30x TMV 3	103.83	-1.82	2.46	0.34	16.60	-0.61
39	OMT 30x VRI 1	113.20	2.63	2.13	-0.37	15.92	2.19
40	OMT 30x SVPR 1	107.00	5.30	2.53	0.15	19.70	1.24
41	DPI 1424x Co 1	101.96	0.64	2.79	0.28	9.31	0.09
42	DPI 1424x TMV 3	95.63	3.16	2.26	0.17	14.77	1.59
43	DPI 1424x VRI 1	95.03	2.89	2.77	0.11	16.72	0.84
44	DPI 1424x SVPR 1	83.49	0.34	2.17	-0.40	12.38	0.58
45	PSR 2007x Co 1	104.92	1.34	2.61	0.50	14.35	-0.10
46	PSR 2007x TMV 3	86.98	1.31	2.59	-0.01	15.21	-0.38
47	PSR 2007x VRI 1	100.79	-2.45	2.77	0.30	12.70	-0.12
48	PSR 2007x SVPR 1	97.39	0.82	2.14	-0.39	14.91	-0.65
49	B 203x Co 1	95.92	-1.25	2.68	0.26	11.53	-0.51
50	B 203x TMV 3	89.11	-1.14	3.00	0.08	14.37	-1.15
51	B 203x VRI 1	95.40	1.69	2.28	-0.40	12.78	0.80
52	B 203x SVPR 1	95.22	0.50	2.33	0.13	18.50	-0.10
53	Si 42x Co 1	87.70	1.32	2.32	-0.42	14.53	-0.39
54	Si 42x TMV 3	82.18	0.09	2.32	0.04	14.71	-0.51
55	Si 42x VRI 1	91.21	1.04	2.24	-0.10	15.83	-0.34
56	Si 42x SVPR 1	103.61	0.16	2.22	-0.33	9.98	0.58
57	Si 3216x Co 1	86.10	-1.20	2.73	0.11	14.76	-0.13
58	Si 3216x TMV 3	82.52	-1.62	2.75	0.33	11.62	-0.05
59	Si 3216x VRI 1	87.52	1.95	2.78	0.19	12.20	0.20
60	Si 3216x SVPR 1	96.56	0.64	2.09	-0.37	10.92	-0.22
61	Si 3315/11x Co 1	98.90	1.25	2.62	0.23	14.29	-0.43
62	Si 3315/11x TMV 3	94.07	-0.49	2.83	0.15	13.59	-0.69
63	Si 3315/11x VRI 1	86.94	-1.27	2.62	0.34	13.89	0.36
64	Si 3315/11x SVPR 1	91.79	-0.41	2.27	-0.28	**13**.00	0.20
	E_1	80.03	-4.26	2.34	-0.30	11.92	-0.62
	E_2	84.87	-5.04	2.34	1.45	14.45	-3.24
	E_3	103.85	9.31	2.89	-1.14	13.35	3.87

Fig.1. Biplot graph for mean and PCA 1 for number of capsules

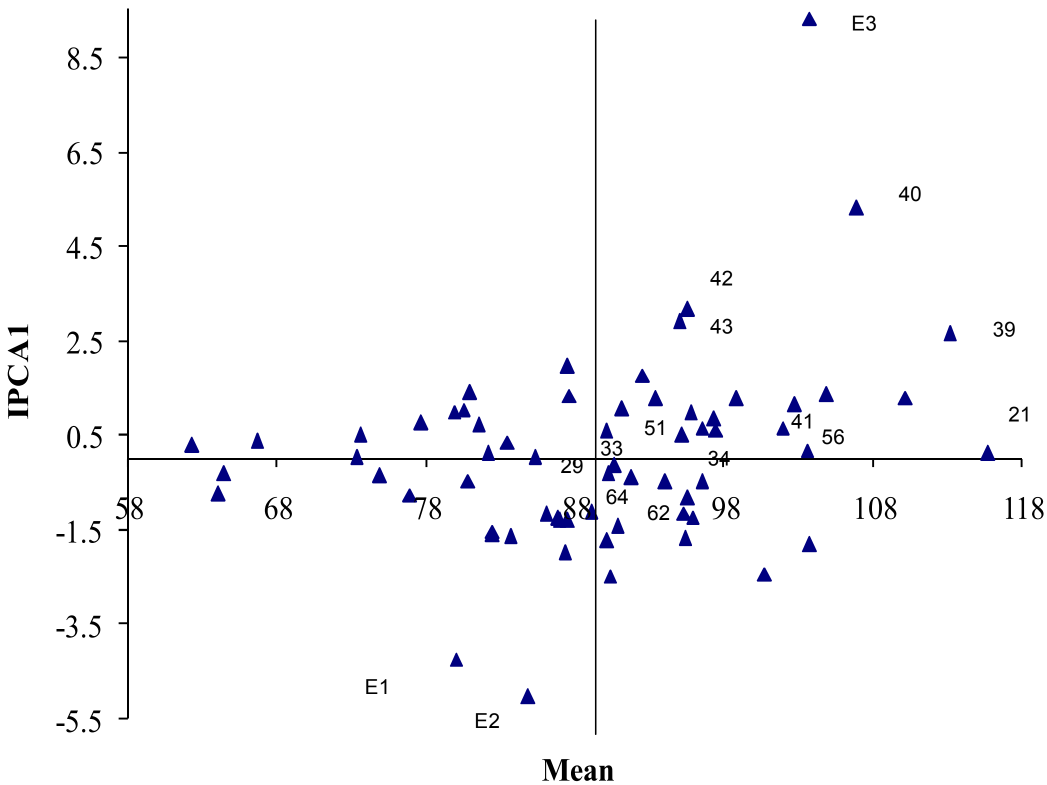

Fig.2. Biplot graph for mean and PCA 1 for1000 seed weight

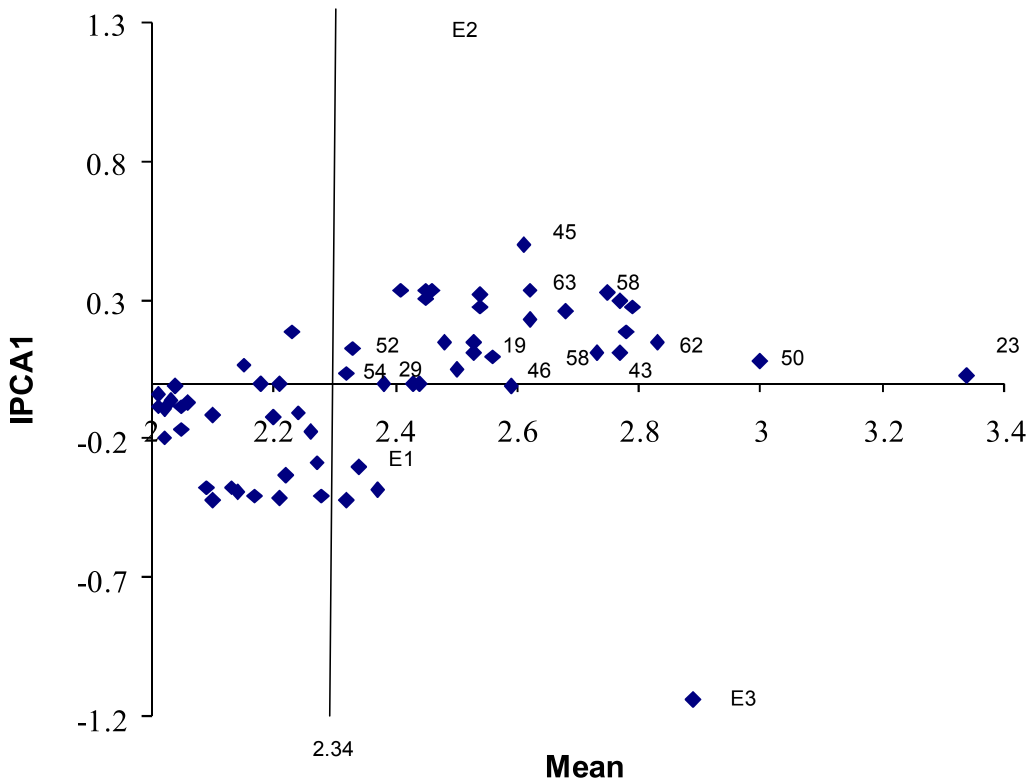

Fig.3. Biplot graph f or mean and PCA 1 for Single plant yield