1704 Use of high efficient AMMI method to evaluate new Egyptian cotton genotypes for performance stability

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Thirty six genotypes were grown at five locations over Nile Delta of Egypt. New approach for the additive main effect and multiplicative interaction AMMI method was applied. Where the effect of all interaction components combined in one number named Total Percentage of Absent Interaction (TPAI). The biplot of mean performance and TPAI may help the breeder to select genotypes which combine both stability and high performance for the studied traits. Highly significant mean square was obtained for genotypes, genotype-environment interaction and IPCA1 for all traits. The mean square for IPCA2 was highly significant for all traits except seed index where it was significant. The contribution of IPCA 1 for G x E sum squares was greater for lint percentage followed by seed-cotton yield. The highest contribution for IPCA 2 was for seed-cotton yield. Most of G x E sum squares, for all traits, could be attributed to IPCA 1, IPCA 2 and IPCA 3.

The best genotypes were F_6 661/03 (12), F_{12} 854/03 (28), F_{12} 865/03 (29) and G.89G.86 (32) where they exhibited high yield with high stability level for all traits. They followed by F_9 802/03 (24) which bosses the highest yield with average stability for all traits.

Introduction

Dimitrios *et al* (2006) reported that AMMI 1 had high repeatability by increasing number of testing environments. McNew *et al* (2005) selected no-interaction stability for the analysis of the variety test data in order to evaluate variety stability. Bowman (2004) reported that most of stability methods cannot combined yield to produce one number. Many investigators emphasized the Additive Main Effect and Multiplicative Interaction (AMMI) model as a tool to analyze genotype-environment interaction and to define stability for each genotype (Kempton (1984), Gauch (1985, 1988, 1990a, 1990b and 1992), Gauch and Zobel (1988 and 1989), Zobel *et* al (1988), Corssa (1990), Corssa *et* al (1990 and 1991). The AMMI model was applied for *Gossypium hirsutum* by Gutierrez *et al* (1994), Cruz-Medina and Hernandez-Jasso (1994)and Jones *et al* (2003). It was applied for *Gossypium barbadense* by El-Shaarawy (1998a, 1998b and 2000).

In order to increase the accuracy of the AMMI method El-Shaarawy (1998b and 2000) suggested a confidence limits to define the area where the interaction principal component Axis (IPCA) equal zero. The objective of the present investigation is to present more suggestions to increase the accuracy and to reduce the number of biplots to be one for each trait. Where the effect of all interaction components combined in one number named Total Percentage of Absent Interaction (TPAI). The biplot of mean performance and TPAI may help the breeder to select genotypes which combine both stability and high performance for the studied traits.

Materials and Methods

Thirty six genotypes (*Gossypium barbadense*) were evaluated in a randomized complete block design at five locations (over Nile Delta of Egypt) in 2005. The five locations were

Sakha, El-Sharkia, El-Gharbia, El-Behera and Damieta. The genotypes were three commercial varieties (Giza 89, Giza 86 and Giza 85), two promising crosses (G.89G.86 and G.89LS6) and thirty one breeding lines (derived from twenty six crosses). Five traits (seed-cotton yield, lint yield, lint percentage, seed index and lint index) were studied. The data from the five locations were analyzed using a computer program written (in BASIC) according to the method outlined by Gauch (1992) for AMMI analysis. The AMMI model equation is:

$$Y_{ger} = \mu + \alpha_g + \beta_e + \Sigma_n \lambda_n \gamma_{gn} \dot{o}_{en} + \rho_{ge} + \varepsilon_{ger}$$

Where Y_{ger} is the plot of genotype g in the environment e and replicate r; μ is the grand mean; α_g is the deviation of the genotype g from the grand mean; β_e is the deviation of the environment e from the grand mean; λ_n is the singular value of PCA axis n; γ_{gn} is the genotype eigenvector for axis n; $\dot{o}_{en}$ is the environment eigenvector; ρ_{ge} is the residual of the genotype-environment interaction and ε_{ger} is the error term.

The confidence limits, suggested by El-Shaarawy (1998b and 2000) , were calculated using the following formula:

$\pm t_{0.05} ((\Sigma S^2 / (g-1))/g)^{1/2}$

;1CAIP .e.i)Where S is the absolute value the IPCA scores for which the confidence limits calculated
.1-g =and df 0.05 =value for p -is the tabulated $t_{0.05}$ g is the number of genotypes and t ;(or IPCAn.......;2IPCA

The Total Percentage of Absent Interaction (TPAI) was calculated by using the confidence limits and the percentage contribution of each IPCA component sum square to G x E sum square. For example, assuming that the percentage contribution of IPCA 1, IPCA 2 and IPCA 3 were 40, 30 and 20%, respectively and the scores calculated for the three components were inside the confidence limits for the genotype No.1 then its TPAI=40+30+20=90%. If the scores of two components only (IPCA 1 and IPCA 3) were inside the confidence limits for the genotype No.2 then its TPAI=40+20=60%. If the scores were outside the confidence limits for all components for the genotype No.2 then its TPAI=0 and so on.

Results and discussion

The mean squares for environments (E), genotypes (G), G x E interaction and first interaction principal component axis (IPCA 1) was highly significant for all traits (Table 1). IPCA 2 showed highly significant mean square for all traits except seed index where, it was significant. The mean Squares for IPCA 3 was highly significant for lint index and significant for lint percentage and seed index, respectively. The contribution of IPCA 1 for G x E sum squares was greater for lint percentage followed by seed-cotton yield (Table 2). The highest contribution for IPCA 2 was for seed-cotton yield. Most of G x E sum squares, for all traits, could be attributed to IPCA 1, IPCA 2 and IPCA 3.

Table 3 shows both TPAI and mean performance for each trait of different genotypes. The same data were shown by biplots in Fig. 1, Fig. 2, Fig. 3, Fig. 4 and Fig. 5 for seed-cotton yield, lint yield, lint percentage, seed index and lint index, respectively. For seed-cotton yield, ten genotypes showed the highest level of stability (TPAI = 88.23 %). Two genotypes (F_6 661/03 (12) and F_{12} 854/03 (28)) were the best of this group where they showed above average seed-cotton yield with the highest level of stability (Fig. 1). The next level of stability (TPAI = 73.14 %) showed by eight genotypes. The best of them were F_{12} 865/03

(29), F_{13} 872/03 (30) and G.89G.86 (32) where they exhibited high seed-cotton yield with high level of stability. The highest seed cotton-yield was noticed for F_9 802/03 (24) which showed average level of stability (TPAI = 53.64 %).

Ten genotypes showed the highest level of stability (TPAI =88.57 %) for lint yield (Fig. 2). Two of them (F_6 661/03 (12) and F_{12} 854/03 (28)) were the best where they bosses both high lint yield with the highest stability. The next group contains six genotypes (TPAI = 71.3 %). Genotype F_{12} 865/03 (29) was the best where it showed nearly highest lint yield with high stability. The highest lint yield was recorded by F_9 802/03 (24) which showed average level of stability (TPAI = 54.76 %).

Regarding lint percentage (Fig. 3), fourteen genotypes exhibited the highest stability level (TPAI = 87.58 %). Among of them nine genotypes (F_6 654/03 (11), F_6 699/03 (15), F_{12} 865/03 (29), G89LS6 (33), F_{13} 872/03 (30), G.89G.86 (32), F_9 815/03 (25), F_{12} 854/03 (28) and F_6 661/03 (12), in arrangement) bosses high lint percentage and highest stability level. The next group contain six genotypes with low lint percentage and moderate stability (TPAI 63.25-67.93).

For seed index (Fig. 4), eleven genotypes showed the highest stability level (TPAI = 85.72 %). Four genotypes (F_6 621/03 (7), G.89G.86 (32) Giza 86 (35) and F_6 717/03 (17)) were the best of them where they combined both high seed index and highest stability. The next group contains twelve genotypes with moderate stability (TPAI = 61.09 %). Among of them F_5 624/03 (8) was the best where it showed the highest seed index.

Eleven genotypes showed the highest stability level (TPAI = 88.03) for lint index (Fig. 5). Among of them five genotypes (Giza 86 (35), G.89G.86 (32), F_6 717/03 (17), F_{12} 865/03 (29) and F_7 791/03 (22)) were the best where they showed high lint index with highest stability. The next group contains four genotypes exhibited high stability (TPAI = 68.84 %). Both F_6 654/03 (11) and F_5 624/03 (8) showed the highest lint index.

Over all traits, the best genotypes were F_6 661/03 (12), F_{12} 854/03 (28), F_{12} 865/03 (29) and G.89G.86 (32) where they exhibited high yield with high stability level for all traits. They followed by F_9 802/03 (24) which bosses the highest yield with average stability for all traits.

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References

Bowman, D. T. 2004. Stability analysis: Pros and Cons. 2004 Proceedings Beltwide Cotton Conferences. January 5-9 San Antonio, TX 1063.

Dimitrios Baxevanose, Gianuli Larissa, Jesus Rossi, Goula, C. and Tzortios, S. 2006. Repeatability of yield stability statistics in cotton. 2006 Proceedings Beltwide Cotton Conferences. January 3-6 San Antonio, TX 866-873.

Crosa, J. 1990. Statistical analysis of multiplication trials. Advanced in Agronomy 44:55-85.

Crosa, J., Gauch, H. G. and Zobel, R. W. 1990. Additive main effects and multiplicative interaction analysis of two international maize cultivar trials. Crop Science 30:493-500.

Crosa, J., Fox, P. N., Pfeiffer, W. H., Rajaram, S. and Gauch, H. G. 1991. AMMI adjustment for statistical analysis of an international wheat yield trial. Theoretical and Applied Genetics 81:27-37.

Cruz-Medina, R. and Hernandes-Jasso, A. 1994. Genotype-environment interaction analysis with the AMMI model. A tool to determine adaptability of Upland cotton genotypes in Spain. 1994 Proceedings Beltwide Cotton Conferences. January 5-8 San Diego, CA 690-692.

El-Shaarawy, S. A. 1998a. Use of AMMI model to analyze genotype-environment interaction for Egyptian cotton. Egypt. J. Agric. Res. 76(2):773-783.

El-Shaarawy, S. A. 1998b. Suggestions to improve the AMMI method for measuring stability of genotypes. Proceedings of the World Cotton Research Conference 2. Athens, Greece, Septemper 6-12, 1998:148-153.

El-Shaarawy, S. A. 2000. Moddified AMMI method for measuring performance stability for different genotypes over different environments. 2000 Proceedings Beltwide Cotton Conferences. January 5-8 San Antonio, TX 690-692.

Gauch, H. G. 1985. Integrating Additive and Multiplicative Models for Analysis of Yield Trials with Assessment of Predictive Success, Mimeo 857. Soil, Crop and Atmospheric Sciences, Cornel University, Ithaca, New York.

Gauch, H. G. 1988. Model selection and validation for yield trials with interaction. Biometrics 44:705-715.

Gauch, H. G. 1990a. Using interaction to improve yield estimates. In Genotype-by-Environment interaction, editor M.S. Kang, Department of agronomy, Louisiana State University, Baton Rouge, Louisiana, pages 141-150.

Gauch, H. G. 1990b. Full and reduced models for yield trials with interaction. Applied Genetics 80:153-160.

Gauch, H. G. 1992. Statistical analysis of regional yield trials: AMMI analysis of factorial designs. Elsevier Science Publishers B. V. Amesterdam-London-New York-Tokyo 1992.

Gauch, H. G. and Zobel, R. W. 1988. Predictive and postdictive success of statistical analysis of yield trials. Theoretical and Applied Genetics 76:1-10.

Gauch, H. G. and Zobel, R. W. 1989. Accuracy and selection success in yield trial analysis. Theoretical and Applied Genetics 79:751-761.

Gutierrez, J. C., Lopez M. and El-Zik, K. M. 1994. AMMI (Additive main effects and multiplicative interaction analysis) : A tool to determine adaptability of Upland cotton genotypes in Spain. 1994 Proceedings Beltwide cotton Conferences. January 5-8, San Diego, CA 688-689.

Jones, D. G., Thexton, Peggy S. and Smith, C. W. 2003. Stability of yield and fiber in the Texas Germplasm. 2003 Proceedings Beltwide Cotton Conferences. January 6-10 Nashville, TN 821.

Kempton, R. A. 1984. The use of biplots in interpreting variety by environment interactions. Journal of Agricultural Science, Cambridge 103:123-135.

McNew, R., Gwathmey, O., Craig, C., Phipps, B, and Bourland, F. 2005. Stability of yield and fiber quality in the North Delta: 1. Evaluation of methods. 2005 Proceedings Beltwide Cotton Conferences. January 4-7 New Orleans, Louisiana 981-986.

Zobel, R. W., Wright, M. J. and Gauch, H. G. 1988. Statistical analysis of a yield trial. Agronomy Journal 80:388-393.

Table 1: Mean squares for seed-cotton yield, lint yield, lint percentage, seed index and lint index.

S.V.	d.f.	Traits				
		S.C.Y.	L.Y.	L%	S.I.	L.I.
Replicate within	10	8.518 **	14.177 **	3.868 **	0.357	0.082
Environments (E)	4	236.870 **	371.476 **	57.413 **	39.812 **	** 4.956
Genotypes (G)	35	10.797 **	15.372 **	24.081 **	3.178 **	2.372 **
G x E	140	2.646 **	3.880 **	2.520 **	0.441 **	0.310 **
IPCA1	38	3.758 **	5.359 **	4.050 **	0.580 **	0.405 **
IPCA2	36	3.559 **	5.101 **	2.384 **	0.436 *	0.402 **
IPCA3	34	1.644	2.758	2.039 *	0.447 *	0.245 **
Residual	32	1.363	1.940	1.368	0.276	0.162
Error	350	1.580	2.297	1.395	0.271	0.139

*, ** Significant at p = 0.05 and p = 0.01, respectively

Table 2: Percentage contribution of IPCA components to genotype-environment interaction sum square.

S.V.	Traits				
	S.C.Y.	L.Y.	Lint%	S.I.	L.I.
IPCA1	38.55	37.49	43.61	35.68	35.44
IPCA2	34.59	33.81	24.32	25.41	33.40
IPCA3	15.09	17.27	19.64	24.63	19.19
Total	88.23	88.57	87.58	85.72	88.03
Residual	11.77	11.43	12.42	14.28	11.97

Table 3: Mean performance of thirty six genotypes over five environments.

No.	Genotypes	Traits									
		SCY		LY		LP		SI		LI	
		TPAI	C/F	TPAI	C/F	TPAI	%	TPAI	gm	TPAI	gm
1	F_5 556/03	15.09	7.41	17.27	8.53	24.32	36.17	85.72	9.7	35.44	5.52
2	" 571/03	88.23	7.47	88.57	8.07	19.65	34.15	35.68	10.2	35.44	5.31
3	" 597/03	15.09	8.79	17.27	10.33	63.25	37.26	50.04	10.2	54.63	6.03
4	" 602/03	73.14	8.55	71.30	10.02	43.97	37.01	60.31	10.7	88.03	6.26
5	" 604/03	0	8.51	0	10.01	87.58	37.28	85.72	10.4	88.03	6.19
6	" 609/03	49.67	7.02	17.27	8.37	43.47	37.64	61.09	11.0	33.40	6.63
7	" 621/03	53.64	8.18	0	9.21	87.58	35.71	85.72	11.0	68.84	6.08
8	" 624/03	88.23	7.44	88.57	8.71	43.97	37.08	61.09	11.5	68.84	6.74
9	" 629/03	73.14	7.65	71.30	9.57	43.61	39.52	50.04	10.2	19.19	6.63
10	" 644/03	88.23	7.34	88.57	8.30	43.61	35.76	35.68	10.3	88.03	5.73
11	F_6 654/03	88.23	6.66	88.57	8.39	87.58	39.90	61.09	10.3	68.84	6.80
12	" 661/03	88.23	8.50	88.57	10.10	87.58	37.65	85.72	10.2	88.03	6.17
13	" 664/03	38.55	8.11	37.49	9.31	67.93	36.48	61.09	10.7	68.84	6.15
14	" 674/03	49.68	8.20	51.08	9.84	43.97	38.10	60.31	10.8	54.63	6.65
15	" 699/03	49.68	7.52	0	9.08	87.58	38.27	50.04	10.9	52.59	6.75
16	" 711/03	73.14	6.82	71.30	8.56	19.65	39.95	85.72	10.2	54.63	6.75
17	" 717/03	15.09	7.61	51.08	8.99	87.58	37.38	85.72	10.7	88.03	6.39
18	F_7 757/03	34.59	7.04	88.57	8.12	0	36.88	61.09	9.2	54.63	5.41
19	" 764/03	0	7.98	37.49	9.31	63.25	36.89	60.31	10.5	33.40	6.13
20	" 774/03	53.64	9.17	17.27	10.17	0	34.98	61.09	10.8	0	5.79
21	" 789/03	73.14	7.91	71.30	9.20	63.25	36.86	24.63	11.0	54.63	6.43
22	" 791/03	88.23	7.10	88.57	8.22	87.58	36.63	61.09	11.0	88.03	6.35
23	F_8 794/03	49.68	9.37	51.08	11.04	43.97	37.40	60.31	10.6	19.19	6.32
24	F_9 802/03	53.64	9.96	54.76	11.38	67.93	36.22	50.04	11.0	88.03	6.24
25	" 815/03	49.68	7.44	17.27	8.90	87.58	37.86	85.72	10.3	54.63	6.29
26	" 829/03	15.09	7.62	17.27	8.45	43.61	35.10	35.68	11.1	52.59	5.98
27		38.55	8.09	0	9.34	67.93	36.53	24.63	9.6	52.59	5.53

28	" 832/03	88.23	8.53	88.57	10.13	87.58	37.69	85.72	10.0	54.63	6.04
29	F_{12} 854/03	73.14	9.31	71.30	11.25	87.58	38.27	50.04	10.3	88.03	6.37
30	" 865/03	73.14	9.10	37.49	10.95	87.58	38.00	61.09	10.4	35.44	6.39
31	F_{13} 872/03	88.23	7.56	88.57	9.12	0	38.21	35.68	10.3	52.59	6.39
32	F_{14} 894/03	73.14	9.44	33.81	11.27	87.58	37.92	85.72	10.8	88.03	6.59
33	G.89G.86	49.68	9.57	17.27	11.48	87.58	38.12	50.04	10.0	33.40	6.13
34	G.89LS6	88.23	7.54	88.57	8.67	87.58	36.51	85.72	10.0	88.03	5.75
35	Giza 89	88.23	7.74	54.76	9.37	43.97	38.41	85.72	10.8	88.03	6.72
36	Giza 86	73.14	7.55	71.30	9.04	24.32	37.79	24.63	10.4	54.63	6.31
	Giza 85										
L.S.D. 0.05			0.15		0.18		0.14		0.06		0.04
L.S.D. 0.01			0.19		0.24		0.19		0.08		0.06

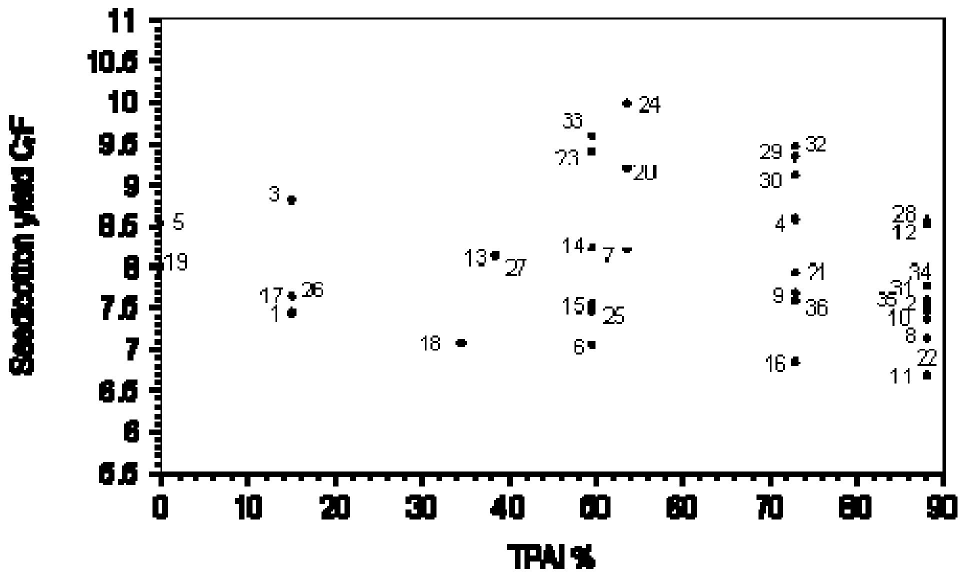

Fig. 1: Biplot of seed-cotton yield mean and total percentage of absent interaction TPAI.

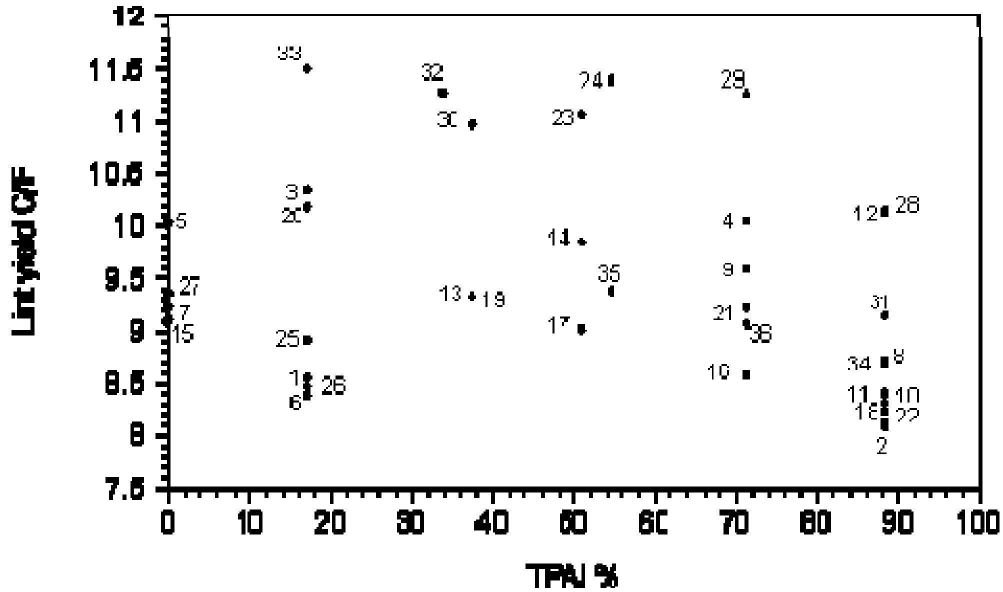

Fig. 2: Biplot of lint yield mean and total percentage of absent interaction TPAI.

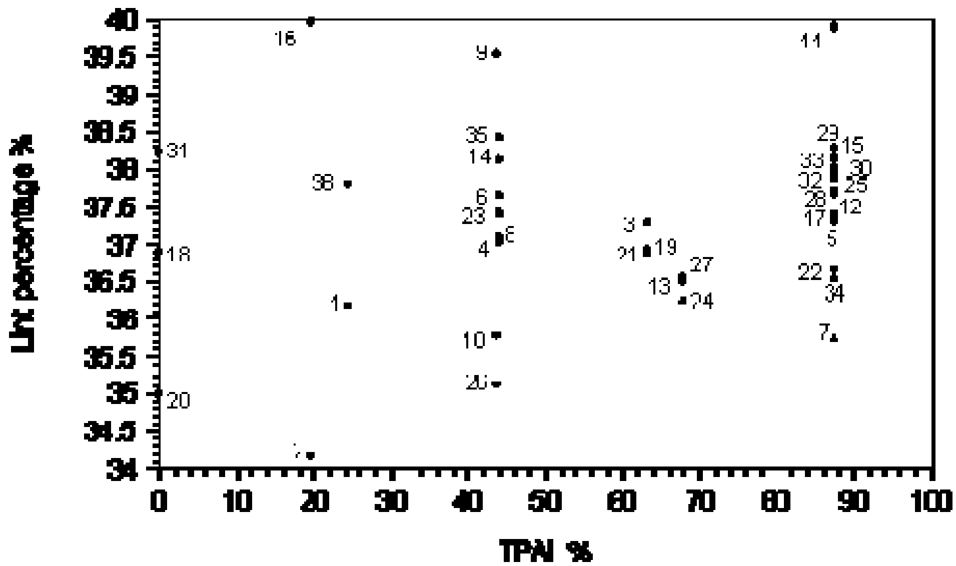

Fig. 3: Biplot of lint percentage mean and total percentage of absent interaction TPAI.

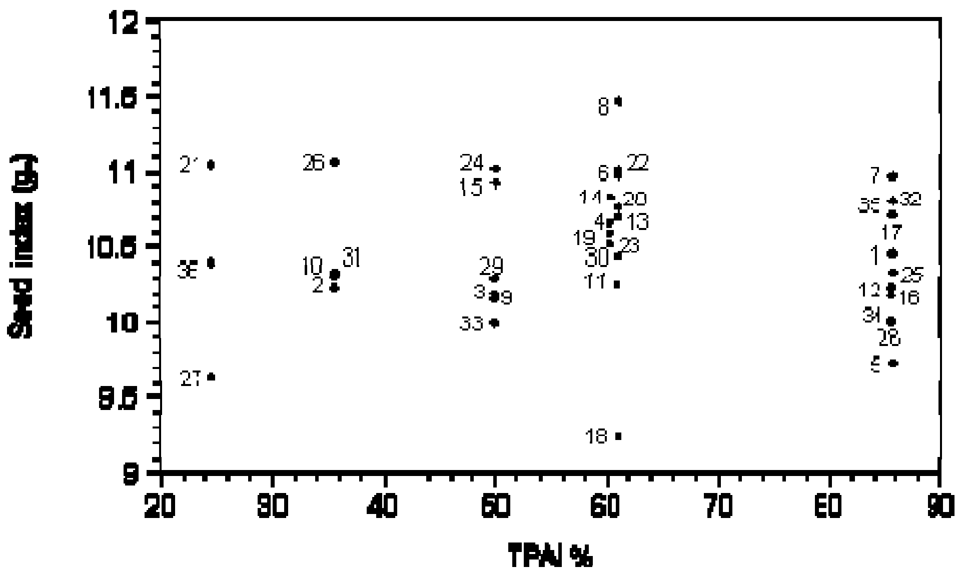

Fig. 4: Biplot of seed index mean and total percentage of absent interaction TPAI.

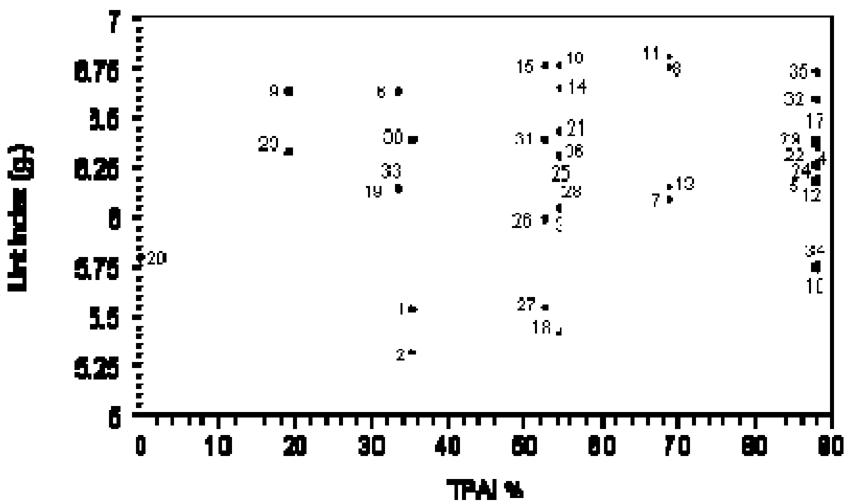

Fig. 5: Biplot of lint index mean and total percentage of absent interaction TPAI.