

ADDITIVE MAIN EFFECTS AND MULTIPLICATIVE INTERACTIONS ANALYSIS ON YIELD PERFORMANCES OF RICE GENOTYPES IN COASTAL SALINE REGIONS, TRA VINH PROVINCE

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ABSTRACT

The study aims at analyzing the pattern of genotype x environment (GxE) interaction for grain yield of 12 genotypes by AMMI mode. Eight-site yield trial in east-coastal region of Tra Vinh province involved in study. The GxE interaction influenced the relative ranking of the genotypes under salt stress environment condition. Among the genotypes tested, in 2009-2010 Winter- Spring, almost all varieties tested exhibited their adaptability to 8 locations of Tra Vinh province. The selected genotypes could be listed as OM10041, OM8927, OM4488, OM10040, OM5894, and OM7348. They expressed their stable yield over 8 sites. Especially, OM10041 is now considered as a promising genotype that gives yield of 7.8 ton/ha. In addition, there are still some elite lines as AS996, OM10029, OM8104, OM10383, OM5953 and OM10029 available to further develop. Two genotypes could be recommended to grow under unfavorable conditions as OM4488 and OM7347.

Keywords: AMMI, GxE interaction, salinity

INTRODUCTION

The genotype x environment interaction is important for plant breeding because it affects the genetic gain and selection of cultivars with wide adaptability (Deitos *et al.*, 2006, Souza *et al.*, 2009). On the other hand, different genotypes have different performance in each region that can be capitalized to maximize productivity (Souza *et al.*, 2008). Eberhart and Russell (1966) developed a methodology for identifying cultivars with greater adaptability and stability that has been widely used in the identification of genotypes for this purpose (Miranda *et al.*, 1998, Grunvald *et al.*, 2008). Numerous methods have been developed to reveal patterns of GxE interaction, such as joint regression (Finlay and Wilkinson, 1963; Eberhart and Russel, 1966; Perkins and Jinks, 1968), additive main effects and multiplicative interaction (AMMI, Gauch 1992). Therefore, the calculation of genotype and environment interaction is essential for

breeders to select varieties with high yield and stable in different environments, especially in favorable and unfavorable environments.

MATERIALS AND METHODS

Multilocal yield trials were conducted in 8 sites as Chau Thanh, Tieu Can, Can Long, Kinh Xang, Ba Mi, Giong Dau, Tra Met, CLRRI, with 12 prominent varieties in 2009-2010. The experiments were laid out in RCBD with three replications. Transplanting (1 plant/hill) was applied with the spacing of 15x20 cm and formula of fertilizer was 100-40-30 kg NPK/ha and 80-40-30 kg NPK/ha in Winter-Spring and Summer-Autumn, respectively. Seed rate of 100kg/ha was applied in case of direct seeding. Samples were harvested in 10 m² per plot to obtain grain yield.

GxE interaction analysis was calculated based on Eberhart and Russel's model in 1966, as following formula:

$$Y_{ij} = \mu_i + \beta_{ij} + \delta_{ij} \quad \text{with} \quad I_j = \frac{(\sum Y_{ij}/V) - (\sum \sum Y_{ij}/vn)}{V}$$

where,

Y_{ij} : the mean performance of i^{th} genotype in j environment

μ_i : general mean of i^{th} genotype
 β_{ij} : deviation from regression of i^{th} genotype in the j^{th} environment

I_j : the environment index, which is defined as deviation of mean of all genotypes at a given environment from the overall mean.

RESULTS AND DISCUSSION

✚ In 2009-2010 Winter-Spring

Table 1. Preliminary grain yield at 8 sites (t / ha)

No.	Designation	Chau Thanh	Tieu Can	Cang Long	Kinh Xang	Ba Mi	Giong Dau	Tra Met	CLRRI
1	OM10040	7.50	7.10	7.30	7.70	7.60	7.70	7.20	6.50
2	OM5953	8.10	8.00	7.90	7.50	7.40	7.60	7.40	6.40
3	OM8104	8.40	7.40	7.70	7.10	7.40	7.80	7.60	6.10
4	OM5894	7.20	7.10	7.40	7.60	7.50	7.90	7.80	6.70
5	OM10029	7.60	7.60	7.80	7.10	6.80	7.80	7.90	6.40
6	OM8927	6.80	7.50	7.70	7.70	6.60	7.60	7.40	6.50
7	OM10041	8.10	7.90	8.20	8.20	7.80	7.50	7.60	7.10
8	OM7347	7.90	7.60	7.40	8.10	8.10	7.70	7.60	7.40
9	OM7348	7.60	7.10	7.60	7.70	7.50	7.40	7.80	6.80
10	OM10383	7.10	6.30	7.80	6.50	7.40	6.10	7.40	6.40
11	OM4488	7.90	7.20	7.10	6.80	7.60	6.80	7.80	7.10
12	AS996 (check)	7.50	7.00	7.40	6.40	6.60	5.40	6.80	6.30

Table 2. Yielding of varieties tested in 8 environments of Tra Vinh province in WS 2009-2010 (ton/ha)

No.	Designation	Chau Thanh	Tieu Can	Cang Long	Kinh Xang	Ba Mi	Giong Dau	Tra Met	Vien Lua	Mean (t/ha)
1	OM10040	7.50	7.10	7.30	7.70	7.60	7.70	7.20	6.50	7.33a
2	OM5953	8.10	8.00	7.90	7.50	7.40	7.60	7.40	6.40	7.54a
3	OM8104	8.40	7.40	7.70	7.10	7.40	7.80	7.60	6.10	7.44a
4	OM5894	7.20	7.10	7.40	7.60	7.50	7.90	7.80	6.70	7.40a
5	OM10029	7.60	7.60	7.80	7.10	6.80	7.80	7.90	6.40	7.38a
6	OM8927	6.80	7.50	7.70	7.70	6.60	7.60	7.40	6.50	7.23ab
7	OM10041	8.10	7.90	8.20	8.20	7.80	7.50	7.60	7.10	7.80a
8	OM7347	7.90	7.60	7.40	8.10	8.10	7.70	7.60	7.40	7.73a
9	OM7348	7.60	7.10	7.60	7.70	7.50	7.40	7.80	6.80	7.44a
10	OM10383	7.10	6.30	7.80	6.50	7.40	6.10	7.40	6.40	6.88b
11	OM4488	7.90	7.20	7.10	6.80	7.60	6.80	7.80	7.10	7.29ab
12	AS996(check)	7.50	7.00	7.40	6.40	6.60	5.40	6.80	6.30	6.68b
	Mean (t/ha)	7.64	7.32	7.61	7.37	7.36	7.28	7.53	6.64	-
	I_j	0.30	-0.02	0.27	0.03	0.02	-0.07	0.18	-0.70	-

The check variety AS996 offered the lowest yield of 6.68 ton/ha and variety OM10041 was the highest yield of 7.8 ton/ha.

Table 3. Ij index against yielding over 8 locations

Locations	Ij	Yield (ton/ha)
Ba Mi	0.30	7.36
Can Long	-0.02	7.61
Chau Thanh	0.27	7.64
Giong Dau	0.03	7.28
Kenh Xang	0.02	7.37
Tieu Can	-0.07	7.32
Tra Met	0.18	7.53
Vien Lua	-0.70	6.64

Note: Ij- Environment index

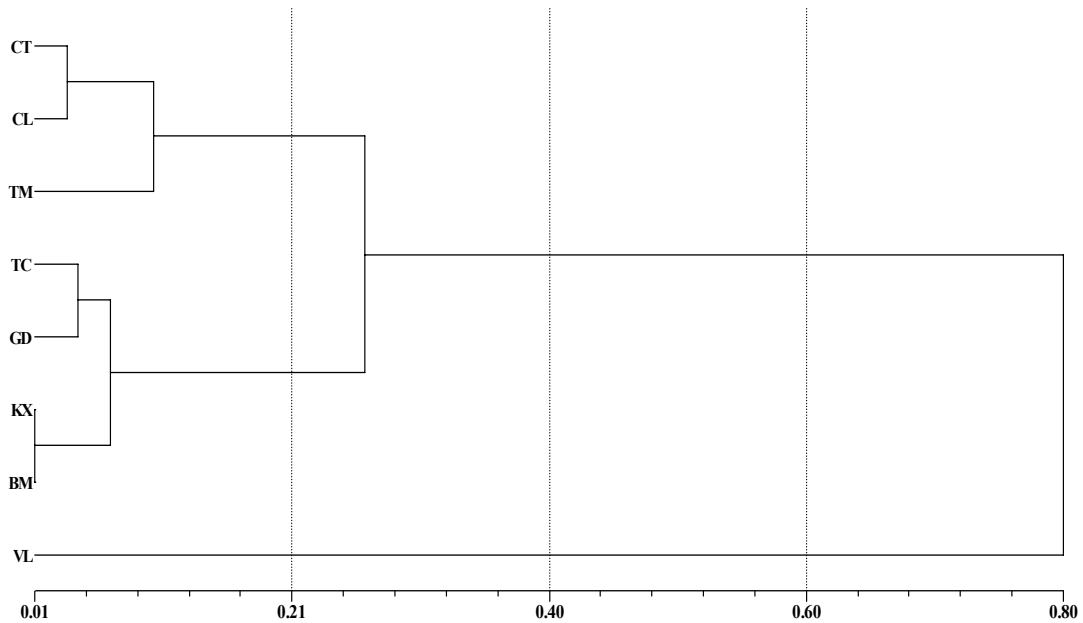


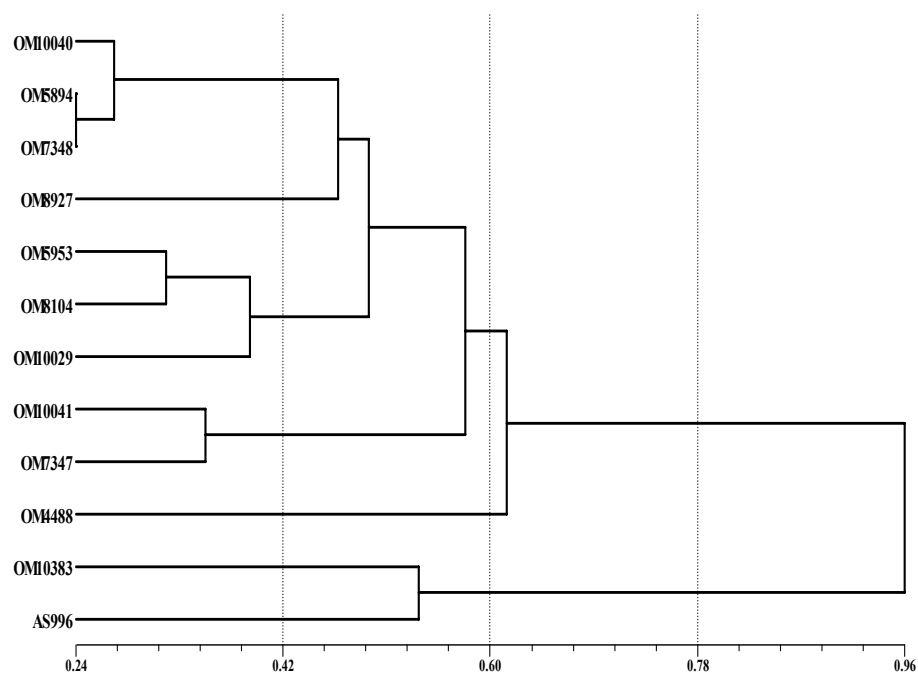
Figure 1. Environment clusters diagram of 8 locations

In figure 1, the environments divided into three clusters at the coefficient of 0.28. Cluster 1 included Vien Lua, in which the grain yield was low. Cluster 2 included Ba Mi, Kenh Xang, Giong Dau, Tieu Can, in which the grain yield (7.3 t/ha) was moderate

so that they were considered as medium environment. Cluster 3 included Chau Thanh, Can Long, Tra Met, in which the grain yield was high so that they were considered the most favorable environment.

Table 4. Average yield (ton/ha) via 8 multilocational trials

No.	Designation	Mean (t/ha)
1	OM10040	7.33a
2	OM5953	7.54a
3	OM8104	7.44a
4	OM5894	7.40a
5	OM10029	7.38a
6	OM8927	7.23ab
7	OM10041	7.80a
8	OM7347	7.73a
9	OM7348	7.44a
10	OM10383	6.88b
11	OM4488	7.29ab
12	AS996(check)	6.68b

**Figure 2.** The genotypes clusters diagram of 12 varieties

The genotypes divided into two main clusters at the coefficient of 0.75.

Cluster A: included two varieties as OM10383 and AS996 (check), which exhibited low yield.

Cluster B: included 10 varieties and it could be divided into 5 different subclusters (B1, B2, B3, B4, B5).

Sub B1: OM4488; Sub B2: OM10041 and OM7347; Sub B3: OM5953, OM8104, OM10029;
Sub B4: OM8927; Sub B5: OM10040, OM5894, OM7348

Table 5. The regression coefficient (b_i) and the stability parameters (s_{di}^2)

Designation	Mean (ton/ha)	b_i	S_{di}^2	Interaction index $R^2\%$
AS996	6,68	1,15	-0.19	1
OM10029	7,38	1,32	0.04	7
OM10040	7,33	0,86	0.08	2
OM10041	7,80	0,98	0.12	0
OM10383	6,88	1,17	-0.12	1
OM4488	7,29	0,56	0.01	11
OM5894	7,40	0,70	0.06	8
OM5953	7,54	1,47	0.10	24
OM7347	7,73	0,28	0.10	42
OM7348	7,44	0,90	0.15	3
OM8104	7,44	1,87	0.08	45
OM8927	7,23	0,74	-0.05	3

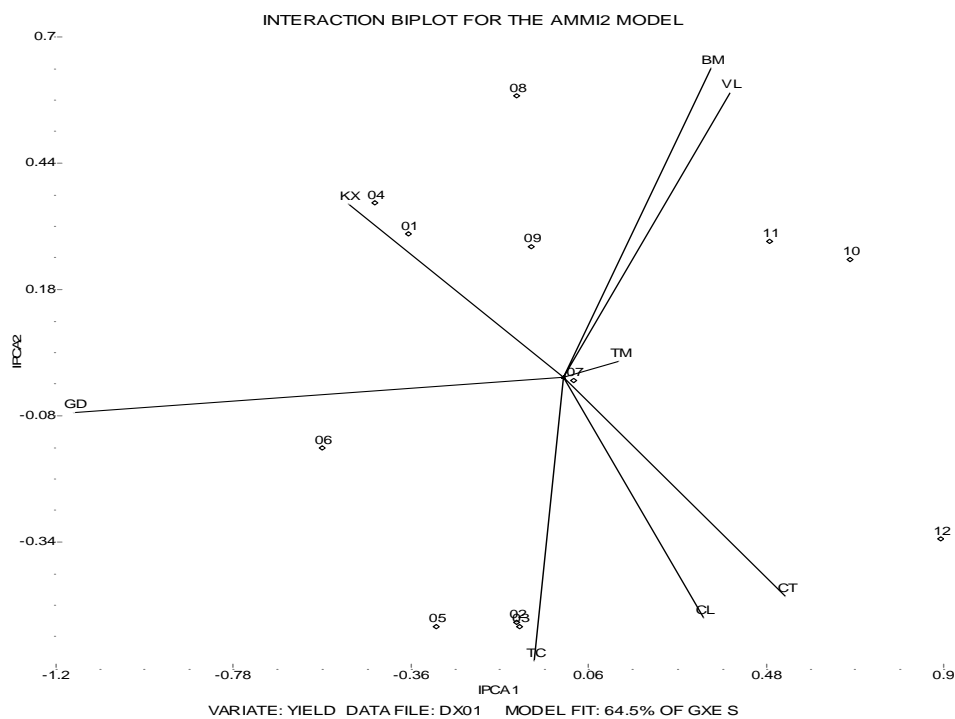


Figure 3. BILOT diagram interaction between 12 genotypes x 8 locations with model fit of 64.5%

Note:

CT	TC	CL	KX	BM	GD	TM	VL
Chau Thanh	Tieu Can	Cang Long	Kinh Xang	Ba Mi	Giong Dau	Tra Met	Vien Lua
1	2	3	4	5	6		
AS996	OM10029	OM10040	OM10041	OM10383	OM4488		
7	8	9	10	11	12		
OM5894	OM5953	OM7347	OM7348	OM8104	OM8927		

OM10041 obtained the highest yield, with b_1 value of 1 around one and S^2_{di} of zero so that its grain yield became very stable among various sites. OM8927, OM10040, OM5894, OM7348 offered the same data so that they must be considered as promising genotypes. Besides that, OM4488 and OM7347 exhibited their good adaptability value but S^2_{di} value lower than zero; it means these genotypes trend to unfavorable adaptation.

Based on BILOT diagram, it can be seen the scatter of genotypes over 8 environments with the emphasis on OM5894 (denoted as number 7), it could be the best genotype among the locations because it located at the centre of the diagram.

CONCLUSION

1. The selected genotypes can be listed as OM10041, OM8927, OM4488, OM10040, OM5894, and OM7348.
2. OM10041 is now considered as a promising genotype obtaining 7.8 ton/ha.
3. In addition, there are still some elite lines as AS996, OM10029, OM8104, OM10383, OM5953 and OM10029 available to further develop.
4. Two genotypes can be recommended to grow under unfavorable conditions as OM4488 and OM7347.

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**PHÂN TÍCH TƯƠNG TÁC $G \times E$ ĐỐI VỚI BỘ GIỐNG LÚA CHỊU MẶN
TẠI VÙNG VEN BIỂN CỦA TRÀ VINH**

Phân tích tương tác kiểu gen x môi trường được thực hiện bằng mô hình AMMI tại 8 địa điểm bị xâm nhập mặn, thuộc vùng ven biển của tỉnh Trà Vinh. Bộ giống lúa bao gồm 8 giống triển vọng có tính thích nghi tốt với vùng đất mặn. Tương tác $G \times E$ có ý nghĩa về mặt thống kê (ĐX 2009-2010) cho phép xem xét ảnh hưởng của từng giống thông qua số liệu phân tích. Giống OM10041, OM8927, OM4488, OM10040, OM5894, OM7348 là những nghiệm thức triển vọng nhất, có năng suất ổn định. Đặc biệt, OM10041 ưu việt nhất có khả năng đạt năng suất 7,8 tấn / ha. Bên cạnh đó, giống AS996, OM10029, OM8104, OM10383, OM5953 và OM10029 cũng cho năng suất đáng kể. Hai giống có tính thích nghi với điều kiện bất thuận là OM4488 và OM7347.