JOURNAL OF AGRICULTURE & SOCIAL SCIENCES
ISSN Print: 1813–2235; ISSN Online: 1814–960X
07–325/AKA/2008/04–1–27–30
http://www.fspublishers.org

Full Length Article

Grain Yield Stability and Adaptability Study on Rice (*Oryza sativa*) Promising Lines

M. SEDGHI-AZAR, G.A. RANJBAR[1]†, H. RAHIMIAN AND H. AREFI‡
Mazandaran University, Mazandaran, Iran
†*Sari Agricultural Sciences and Natural Resources University, Sari, Iran*
‡*Scientific member of Rice Research Institute of Iran*
[1]Corresponding author's email: ali.ranjbar@gmail.com

ABSTRACT

In order to study adaptability and stability of grain yield of various rice promising lines in different regions of Mazandaran province, a comparative study was undertaken for grain yield of 10 rice promising lines and two improved cultivars from 2001 to 2003 in three different regions namely Amol, Sari and Tonekabon. Simple and combined analyses of variances indicated significant differences among grain yield of various lines in all regions. Experimental errors variance was uniform using Bartlet test. Except for effects of year and block × environment (year & location), all effects were significant. Results of grain yield stability analysis indicated significant effects for treatment, environment (linear) and mean squares of deviation from regression. For all lines except line No. 3 there was significant variation for effects of deviation from regression using stability parameters. The highest grain yield was produced by lines No. 7, 8 and 11, showing non significant differences from each other. Nevertheless, for existence of significant differences among deviation from regression by zero, lines could not be recommended for a particular region. The least amount of regression slope belonged to line No. 1, 2 and 5, which were more suitable than others for unfavorable growth conditions. Overall, line No. 3 indicated the highest adaptation and stability for grain yield under different Mazandaran conditions.

Key Words: Rice; Adaptability; Yield stability

INTRODUCTION

Rice (*Oryza sativa* L.) is considered as one of the most important plants from Poaceae. Today, rice has special position as a source of providing over 75% of Asian population and 2.4 billion of world population's meal. This population will increase to over 4.6 billion by 2050 (Kush, 1996; Keshavarzi, 1999; Honarnejad *et al*., 2000), which demands greater crop production.

In breeding programs study and consideration of the amount of adaptability of crops in relation to different environmental conditions, have a special importance. Since there is a dire need for improving suitable varieties more adaptable to different geographical areas. To meet these goals, estimation of genotype × environment interaction is extremely imperative. Overall, adaptable varieties are those cultivars that can express stable genetic potential in different environmental conditions. Varieties in a series of environments have stable average yield are known to have vast adaptability. However, varieties, which show high yielding genetic potential only in desirable conditions but poor yielding potential in un-desirable conditions known as varieties with finite adaptability (Lin & Bins, 1991).

There are a number of statistical methods for consideration of genotype × environment interaction and its relationship with stability. From all of these methods, regression of mean of each genotype on environmental index is one of the most applicable methods (Tesemma *et al*., 1998). This method has been suggested by Finaly and Wilkinson (1963), modified by Eberhart and Russell (1966). For determining adaptability and stability of genotypes in this method, parameters like mean genotypes yield, regression line slope (b_i) and variance of deviation from regression (S^2d_i) are used. In this model various amounts of b_i i.e. b_i =1, b_i<1 and b_i>1 are expressing medium, high and low stability, respectively. According to this model, a genotype is encountered as the most stable that its regression line slope is equal to unit, variance of deviation from regression is the least (non-significant with zero) and its average yield is highest.

Rice varieties responses in different locations and years have been considered by a lot of workers in order to determine yield adaptability and stability (Ram *et al*., 1978; Mahajan & Prasad, 1986; Moeljopawiro, 1989; Gravoic *et al*., 1991). In order to determine adaptability and stability of rice cultivars, Dorosti *et al*. (1997) considered 11 rice cultivars in three environments namely Fouman, Rasht and Astaneh Ashrafieh from 1993 to 1995. Simple analysis of

To cite this paper: Sedghi-Azar, M., G.A. Ranjbar, H. Rahimian and H. Arefi, 2008. Grain yield stability and adaptability study on rice (*Oryza sativa* L.) promising lines. *J. Agri. Soc. Sci.,* 4: 27–30

variance of yield showed significant variations among varieties. In combined analysis, year × location and treatment × year × location interactions were significant. Results of stability analysis based on Eberhart and Russell (1966) showed that line 211 with regression coefficient of 0.22 (having significant difference with unit) had more than medium stability and suitable for environment with low productivity. Other genotypes like lines 222 (Khazar), 414, 415 and 418 had general adaptability and stability but producing inadequate yield. Moreover, their reaction to environmental index (improvement of growth conditions) showed deviations from regression line.

Honarnejad *et al*. (1998) have considered yield of eight rice varieties in 3 locations of Rasht, Lasht-Nesha and Fouman from 1992-1994. Simple and combined analyses showed significant differences among yield performance of the tested cultivars. Treatment × year × location interactions were also significant. Eberhart and Russell (1996) method of analysis for stability showed a significant genotype × environment interaction (linear). Variance of deviations from regression line was significant that was frequently related to lines 400 and 403. Among all tested genotypes, line 397 showed significantly difference in total yield. Genotype 397 with the highest yield, regression line slope of 0.29 and variance of deviations from regression close to zero were introduced as the highly yielding and most stable.

Honarnejad *et al*. (2000) in another experiment used six advanced rice lines together with two improved varieties in three years at three locations (Rasht, Fouman & Astaneh Ashrafieh) for evaluation of adaptability and stability of yield. Simple and combined analyses of variances indicated significant effects for treatment, genotype × location, genotype × year and genotype × location × year interactions. Analysis of stability based on model of Eberhart and Russell (1966) proved a significant effect for regression of cultivars yield on environmental index. Genotype 408 with relatively high yield and regression line slope of equal unit was introduced as the most stable. They also introduced lines 405 and 411 with regression line slope of more than unit as lowly stable genotypes only for productive areas.

The current study determines the stability of grain yield and adaptability of promising lines of rice for ecological conditions of Mazandaran province and also to add knowledge of their physiological response to environmental conditions (locations & years).

MATERIALS AND METHODS

Ten promising rice lines together with 2 improved cultivars were studied for adaptability and stability of grain yield in a multi-location (Amol, Sari & Tonekabon) consideration over three years (2000-2002) in a split-plot in space and time based on a randomized complete block design with four replicates (Table I). Locations and years have been used as main and sub plot, respectively. Each sub-sub-plot contained 25 × 25 cm plant intervals with area of 18 m^2 (6 × 3 m). Crop was harvested at full maturity from 5 m^2 area (80 plant per plot) and after confirmation for uniformity of variance of experimental errors using uniformity test (Bartlett test, χ^2=14.3), combined analysis of three years data have been conducted. Based on random suggestion of year effect and fixed suggestion of genotype and location effects F-test was applied. In order to determine adaptability and stability of grain yield of lines, model of Eberhart and Russell (1966) was used. All statistics was done using SAS software.

RESULTS AND DISCUSSION

Results showed significant differences in the genotypes at all locations. Among considered lines and cultivars there was considerable variation (P<0.01) for grain yield potential (Table II). As uniformity test of error variances was non-significant, therefore its uniformity is confirmed (χ^2 =14.3 <15.51) and then combined analysis of data was conformed (Table III). All factors showed significant effects, except block within environment and genotype × location interaction. A significant effect of location implied that means of treatments varied considerably at different locations. Significant effect of year × location interaction emphasizes that influence of locations on grain yield of rice lines during years are obviously different. Significant effect of treatment × year interaction means that a number of rice lines in whole locations produced higher grain yield in some years, however, a number of rice lines yielded lower during years. Non-significant effect of treatment × location interaction implied that various genotypes had reactions within different locations, so that, sometimes genotype effects in a location can be declined by such effects at another location. Interaction of treatment × year × location showed that variations existed in interaction of treatment × year. Data indicated significant differences of treatment × year × location interaction and implied that application of stability analysis method in present work has logically been permitted (Table IV). These results conform those of Dorosti *et al*. (1997) and Honarnejad *et al*. (2000).

Table I. Identities of considered rice lines

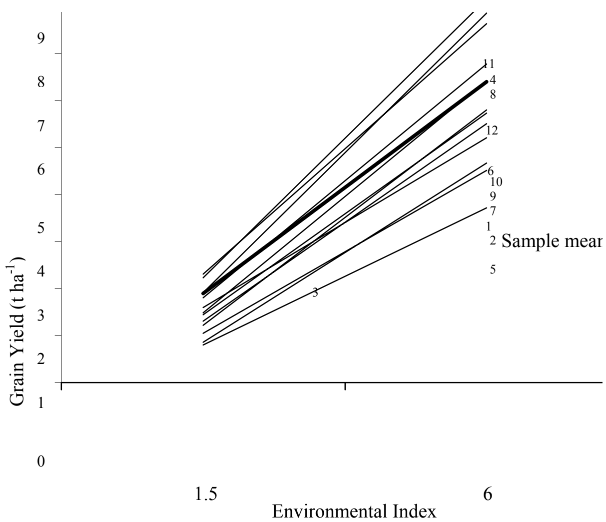
No.	Line No.
1	2738-6-1-2
2	IR 6696-96-4-3
3	IR 67015-23-3-3
4	IR 67017-55-3-5
5	27234-18-1-1
6	27212-4-1-1
7	27212-4-2-1
8	A 5455
9	A 5543
10	A 5601
11	Fajr
12	Neda

Table II. Simple analysis of variance of grain yield of rice lines in three years at three locations

Source of variation	*Degrees of Freedom*	*Means of Squares*								
		2000			**2001**			**2002**		
		Ton	Sari	Amol	Ton	Sari	Amol	Ton	Sari	Amol
Replication	3	10.3	46.6	56.1	42.1	26.4	37.4	13.2	44.2	46.2
Genotype	11	565**	371**	156**	1054**	910**	1733**	565**	44.8**	1265**
Error	33	93.7	66.9	38.6	47.4	43.9	54.8	85.4	47.6	46.2
C.V.	-	6.2	5.4	4.2	5.3	4.7	4.6	5.24	5.4	4.3
$\bar{x}$	-	5204	4917	6364	5845	5597	6069	5893	4836	6346

Ton = Tonekabon, *,** = significant at 5 and 1% levels, respectively, Means of squares have divided by 1000

Fig. 1. Linear response of rice lines to environmental index



Existence of deviation from regression line showed that points related to yield of some genotypes to regression line are scattered by environmental index and response of these lines in linear variations with environment have encountered with fluctuations in data. This is due to significant means of squares for all lines except line No.3 (Table IV), which is in accordance with the findings of Honarnejad *et al.* (2000) and Dorosti *et al*. (1997). This implies that there is non-linear regression among grain yield of rice lines (except line No. 3) and environmental index.

Lines No. 8, 7 and 11 with grain yield of 6.2, 6.06 and 5.9 t ha^{-1} have produced highest yield (Table IV). Although line No. 8 produced highest grain yield and its regression line slope is 1.18 that has no significant difference with unit, its significant deviation from regression (81638.2, P<0.01) implies existence of none linear reaction of its grain yield to environmental index. This point is true for all the same group lines including lines No. 7 and 11.

Line No. 3 with grain yield of 5.5 t ha^{-1} and regression line slope of 1.098 (non-significant with unit) and deviation from regression of 15330.1 (none significant with zero) has the highest stability among all tested lines. Based on correlation of grain yield of rice lines with environmental indices demonstrated that regression lines of line No. 3 is nearly closed to mean line ($b_1 = 1$) (Fig. 1). Therefore, line No. 3 can be recommended for Mazandaran environmental conditions as the most stable and adaptable line.

Table III. Combined analysis of variance of rice lines in three years at three locations

Source of variation	Degrees of Freedom	MS	F
Year (Y)	2	4234425	112**
Location (L)	2	47088211	7.5**
Y × L	4	6275695	166**
Error (a)	27	37576	-
Genotype (G)	11	2831209	5.9**
G × Y	22	478072	81.8**
G × L	22	733585	1.13ns
G × L × Y	44	646587	11**
Error (b)	297	58645	-
Total	431	-	-

** = significant at 1% level, ns = not significant

Table IV. Stability analysis of grain yield of rice cultivars in different environments

Source of variation	DF	Means of squares	F
Total	107	-	-
Genotype (G)	11	707802	5.46**
Environment (E) + (G × E)	96	476183.3	-
Environment (linear)	1	31937014	262.1**
G × E (linear)	11	121825.1	0.94ns
Combined deviations	96	129546.9	8.83**
Genotype 1	7	202756.9	13.8**
Genotype 2	7	108955.3	7.43**
Genotype 3	7	29149.6	1.98ns
Genotype 4	7	335299.1	22.87**
Genotype 5	7	189239.6	12.9**
Genotype 6	7	237437.3	16.19**
Genotype 7	7	241222	16.45**
Genotype 8	7	95457.8	6.51**
Genotype 9	7	59555.2	4.06**
Genotype 10	7	107105.9	7.3**
Genotype 11	7	67137.4	4.57**
Genotype 12	7	103327.8	7.05**
Average Error	297	14661.4	-

ns = not significant differences ** = significant in 1% level

Lines No. 4 and 11 with higher regression coefficient (1.32 & 1.31, respectively) have the most sensitivity to environmental index (linear) and also have specific adaptability to suitable growth areas (Fig. 1). Lines No. 5, 2 and 1 with regression coefficient of 0.649, 0.769 and 0.845, respectively had the least response to environmental index (linear). Therefore, these lines have been recommended for environments with relatively suboptimal growth conditions and thus they have specific adaptability for these areas.

CONCLUSION

Line No. 4 and 11 were be recommended as the most stable and adaptable under all three environments. Although lines No. 8, 7 and 11 produced the highest grain yield, line 11 seemed to be the best choice for homeostasis effects and high yielding character in Mazandaran province.

REFERENCES

Dorosti, H., R. Honarnejad and M.S. Mohammad-Salehi, 1997. Determination of stability and adaptability of rice cultivars in different environmental conditions. *Explants and Seeds*, 4: 30–4

Eberhart, S.A. and W.A. Russell, 1966. Stability parameters for comparing varieties. *Crop Sci*., 6: 36–40

Finaly, K.W. and G.N. Wilkinson, 1963. The analysis of adaptation in plant breeding program. *Australian J. Agric. Res*., 14: 742–54

Gravoic, K.A., A.K. Moldenhauer and P.C. Rohman, 1991. Genetic and genotype × environment effects for rough rice and head rice yield. *Crop Sci*., 31: 907–91

Honarnejad, R., S. Abdollahi, M.S. Mohammad-Salehi and H. Dorosti, 2000. Consideration of adaptability and stability of grain yield of progressive rice (*Oryza sativa* L.) lines. *Res. Agric. Sci.,* 1: 1–9

Honarnejad, R., M.J. Moin and H. Dorosti, 1998. Stability analysis of rice cultivars in some locations of Gillan province. *J. Agric. Sci. Iran,* 29: 723–31

Keshavarzi, M.H., 1999. *Growth Analyses of Crop Plants*, p: 111. Mashad Djahad-Daneshgahi Press

Kush, G.H., 1996. Varietal needs for different environments and breeding strategies. *In*: Siddig, E.A. (ed.), *New Frontiers in Rice Research*, pp: 68–75. Directorate of rice research, Hydarabad, India

Lin, C. and M.R. Bins, 1991. Genetics properties of four types of stability parameter. *Theor. Appl. Genet*., 82: 505–9

Mahajan, R.K. and S.S. Prasad, 1986. Principle component analysis of genotype – environment interactions in rice. *Crop Improv*., 13: 58–62

Moeljopawiro, S., 1989. Genotype-environment interactions of nine rice promising lines. *Indones J. Crop Sci*., 4: 1–8

Ram, C., A. Singh, D.C. Jatasra and D.V. Panwar, 1978. Stability analysis for grain yield in rice genotype-invironment interactions. *Cereal Res. Commun*., 6: 279–84

Tesemma, T., S. Tsegaye, G. Belay, E. Bechere and D. Mitiku, 1998. Stability of performance of tetraploid wheat landraces in Ethiopian highland. *Euphytica*, 102: 301–8

(Received 15 September 2007; Accepted 14 December 2007)