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STABILITY OF RICE HYBRIDS IN VARIABLE ENVIRONMENTS

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ABSTRACT

Four hybrids rice genotypes and two pure lines were evaluated under three nitrogen levels(25, 50, and 75 Kg N/feddan) and three transplant spacing(20x15, 20x20 and 20x25 cm). The rice genotypes differed in their genetic potential for all studied traits, where mean squares for genotypes were highly significant for all traits. The hybrid 1R, 64608A x Suweon 287R revealed the highest mean number of spikelets/panicle, number of filled grains/panicle, 1000-grain weight and grain yield. The environment effects were highly significant for all traits, except for 1000-grain weight that was mainly genetically controlled. Mean squares due to the first, second and third order interactions were highly significant for all traits except for genotype x year x density interaction for number of spikelets/panicle. The simultaneous considerations of b, r^2 , w and mean ($\bar{x}$) parameters showed that some genotypes could be considered the most stable for specific traits i.e

IR 64608B and Sakha 104	***(for Fertility percentage),***
IR 64608A x IR35366-62-1-2-2-3R	***(for panicles/plant),***
IR 64608A x IR35366-62-1-2-2-3R	***(for filled grains/panicle),***
IR 64608A x IR35366-62-1-2-2-3 and Sakha 104	***(for 1000-grain weight),***
IR 64608A x Suweon 287R and IR 64608A x IR35366-62-1-2-2-3R	***(for grain yield)***

***Adaptability estimates revealed that the rice hybrids IR64608A x IR35366-62-1-2-2-3R, IR64608A x Suweon 287R and IR 68884A x Suweon 287R were well adapted to all environments as indicated by their grain yield that was higher than the grand mean, and the insignificant b_i value. Hybrid IR67701A x IR35366-62-1-2-2-3R had high specific adaptability for rich environment (b>1) while the contrast was true for line IR64608B. Based on superiority value (Pi) across 18 environments, the two hybrids IR64608A x IR35366-62-1-2-2-3R and* IR64608A x Suweon 287R were the most adapted and most favorable regarding their stability.**

Key words*: **Hybrid rice, Nitrogen fertilizer, Plant spacing, Stability***

INTRODUCTION

The interaction between genotype and environment and genotypic stability are of major concern to plant breeders for developing improved cultivars. For a cultivar to be commercially successful, it must perform well across a range of environments in which the cultivar may be grown (Sharma *et al* 1987).

Stability of a cultivar refers to its consistency in performance across environments and it is not affected by the presence of genotype by environment interaction (Sharma *et al* 1987). Many stability measures have been proposed. Finlay and Wilkinson (1963) considered the linear regression (b_i) as a measure of stability, whereas, Eberhart and Russell (1966) mentioned that the linear (b_i) and non-linear (S^2di) components of genotype-environment interaction should be considered while judging the phenotypic stability of a genotype. Lin *et al* (1986) concluded that there were three different concepts of stability: A genotype is considered to be stable if (a) - Its among-environment variance is small. (b)- Its response to environments is parallel to the mean response of all genotypes in the trait. (c)- The residual mean squares from the regression model on the environmental index is small.

So far, stability is studied for conventional cultivars, while hybrid rice cultivars are recently introduced in cultivation. Therefore, the aim of this investigation is to study the stability of some hybrid rice genotypes

MATERIAL AND METHODS

This investigation was conducted using the data obtained from a study on response of hybrid rice to three nitrogen levels (25, 50 and 75 kg N/fed. and different three single plant-hill spacing of 20 × 15 cm, 20 × 20 cm and 20 × 25 cm under Egyptian conditions. Four superior medium grain hybrid rice combinations, namely; IR64608A × IR35366-62-1-2-2-3R, IR64608A × Suweon 287R, IR68884A × Suweon 287R and IR67701A × IR35366-62-1-2-2-3R were obtained in 2001 and 2002 and involved in this study beside two pure line genotypes namely: Sakha 104 rice cultivar and a high grain yield maintainer line IR64608B. A split-split plot design wit the main plots in RCBD and three replications was used in 2002 and 2003 seasons. Nitrogen levels occupied the main plots. Plant spacing was devoted to the sub plots and rice genotypes allocated in the sub-sub plots. Data were recorded on five traits, i.e sterility percentage; calculated as relative ratio of unfilled grains relative to the total number of spikeles/panicle in ten randomly taken main panicles/plot, no. of filled grains/panicle; recorded as average no. of filled grains formed on guarded ten main panicles/plot, no. of panicles/plant; recorded as mean no. of panicles of ten guarded plants/plot, 1000-grain weight g; weight of 1000 rough rice grains randomly taken from each plot and grain yield; recorded as yield of one m^2 from the five inner rows/plot adjusted to 14 %moisture.

The statistical analysis for stability was carried out according to the method described by Eberhart and Russell (1966). The regression coefficient which is the regression of the performance of each variety under different environments on the environmental mean across all genotypes was estimated as follows:

$bi = \Sigma_j\ y_{ij}\ I_j / \Sigma_j I^2_j$ (Finlay and Wilkinson, 1963)

Where:

$I_j = (\Sigma_j\ y_{ji} / v) - (\Sigma_i \Sigma_j\ y_{ij} / vn)$,

$\Sigma_{jI\ j} = 0$

bi = regression coefficient

y_{ij}= a mean performance of character on ith genotype in jth environment j,

I_j = the environmental index,

v = number of genotypes,

n = number of environments.

The deviations from regression was also calculated to provide an estimate of the second stability parameter of Eberhart and Russell (1966) as follows:

$$S^2 di = [\sum_j \hat{\delta}^2_{ij} / n-2] - S^2 e / r,$$

$$\sum_j \hat{\delta}^2_{ij} = [\sum_j y^2_{ij} - \frac{y^2_{i.}}{n}] - \left(\sum_j y_{ij} I_j \right)^2 / \sum_j I^2_j$$

where:

S^2d_i = deviations from regression of each genotype,

S^2e/r = the estimate of pooled error,

$y_{i.}$= total of the ith genotype of all environments.

Another stability measurement, the coefficient of determination (r^2), a statistic suggested by Pinthus (1973), was computed from the linear regression as follows:

$$r^2 = b^2_i S^2_{Ij} / S^2_i \text{ with } S^2_{Ij} = \Sigma I^2_{Ij} / (n-I)$$

Where:

r^2 = coefficient of determination,

bi = regression coefficient,

S^2_i = phenotypic variance,

I_j = environmental index.

Also, a fourth stability measure, the ecovalence (w_i); i.e the contribution of each genotype to the genotype × environment interaction was calculated for each genotype according to the expression of Wricke (1962) as follows:

$$W_j = \Sigma j\,[x_{ij} - x_j]^2 - [x_{i.} - x_{...}]^2$$

where:

$\bar{X}_{ij}$ = a mean performance of character on the i^{th} genotype in j^{th} environment;

$\bar{X}_{.j}$ = mean of the j^{th} environment across all genotypes,

$\bar{X}_{i.}$ = mean of the i^{th} genotype across all environments

$\bar{X}_{..}$ = grand mean.

Moreover, the coefficient of variation (CV%) of each genotype as a measure of stability was calculated (Francis and Kannenberg, 1978) as follows:

$$CV = \frac{S}{\bar{X}} \times 100$$

Where:

S = standard deviation of the environments mean of each genotype.

$\bar{x}$ = is the grand mean of the genotype over all environments.

Rank measurement

To combine the estimates of yield and stability, rank index was used. Ranks were assigned for mean yield with the genotype had the rank of 1. Similarly, ranks were assigned for (S^2d) with the lowest estimated value receiving the rank of 1. Also, ranks were assigned for (1-b)/(SE of b), the lowest value was receiving the rank of 1. Ranks were also assigned for (r^2); the highest value receiving the rank of 1. Ranks were assigned for (w_i); the lowest value receiving the rank of 1.
Three indices were calculated:

1.Index (1)	was derived from the sum of yield rank and b rank
2.Index (2)	from the sum of yield rank and (S^2d) rank and
3.Index (3)	from the sum of yield rank, b-rank and S^2d rank

according to Kang (1988)

RESULTS AND DISCUSSION

Analysis of variance

The analysis of variance for the 6 genotypes across18 environments (Table 1) clearly showed that the years effect was highly significant for all studied traits except for grain yield which was insignificant. The lack of a significant genotype × year (G × Y) interaction indicated that the relative performance of rice genotypes was essentially the same in each of the two years of testing. The differences among genotypes were highly significant

Table (1): Mean squares for yield and its components

Source of variation	No. of filled grains/panicle	No. of panicles/ plant	1000-grain weight	Grain yield
Years (Y)	3187.230**	39.341**	7.17**	0.002
Nitrogen (N)	4688.115**	334.491**	3.473**	0.006*
Plant spacing (D)	1098.476**	443.981**	27.308**	4.874**
Y × N	37.381**	1.241	1.735**	0.058**
Y × D	8.395	3.198*	0.049	0.015**
N × D	409.968**	1.606*	0.778**	0.093**
Y × N × D	12.521	0.821	0.13**	0.193**
Replications	4.989	0.50	0.038	0.002
Genotypes (G)	12304.58**	74.698**	178.99**	6.644**
G × Y	52.078**	51.839**	4.452**	0.168**
G × N	381.14**	2.842**	15.84**	0.173**
G × D	145.447**	7.274**	2.962**	0.182**
G × Y × N	17.290**	3.034**	0.281**	0.049**
G × Y × D	16.278**	5.47**	0.084**	0.099**
G × N × D	118.031**	1.484**	0.459**	0.274**
G × Y × N × D	12.082**	2.207**	0.150**	0.083**
Environments (E)	973.05**	100.88**	4.46	2.983**
G × E	99.58**	6.108**	2.66**	0.153**
Env. (linear)	5519.1**	571.73**	27.37**	16.902**
G × Env. (linear)	49.26	3.184	3.895**	0.066
Pooled deviation	26.77**	1.636**	0.56**	0.042**
Error	5.196	0.485	0.014	0.0018
Pooled error	5.160	0.487	0.018	0.0019

*, ** indicate significance at the 0.05 and 0.01 levels of probability respectively.

for all studied traits, indicating that rice genotypes differed in their genetic potential for grain yield and yield-related traits. Similarly, nitrogen and plant spacing effects were significant or highly significant for all traits. The mean squares due to environments were highly significant for grain yield and yield-related traits except for 1000-grain weight. Therefore it seems that grain weight is mainly genetically controlled character which is less affected by environmental factors (Aly *et al* 1987). Similarly, nitrogen and plant spacing effects were significant or highly significant for all traits. The first as well as the second order interactions were highly significant for all traits. Mean squares due to the genotype × year × nitrogen × plant spacing interaction was highly significant for grain yield and yield related traits. Similar results were obtained by El-Hity (1994).

Sterility percentage

The mean, regression coefficient (b) and deviation from regression are presented in Table 2. The results indicated large variations in regression coefficients showing different responses of the genotypes to the environmental variations. Eberhart and Russell (1966) emphasized that both linear (b) and non-linear S2di components of genotype-environment interaction should be considered while judging the phenotypic stability of a genotype. Some genotypes showed regression coefficients significantly different from unity and/or showed inconsistency of their response to change of environment. So, all genotypes were not stable, as they did not fit the Eberhart and Russell (1966) concept. Breese (1969) and Paroda and Hays (1971) reported that the linear regression (b) could simply be regarded as a measure of response of a particular genotype. Whereas, deviation from regression S^2d_i should be considered as measure of stability. Consequently, Sakha 104 rice cultivar was the most sable genotype, having insignificant S^2d_i and mean sterility percentage was below the grand mean. On contrary, all the other genotypes were unstable, having highly significant deviations from regression values S^2d_i and mean sterility percentage was above the grand mean, except for IR64608B, where mean sterility percentage for IR64608B line was significantly below the overall mean. IR64608B rice line had low mean sterility percentage with low regression value but recorded significant deviation from regression, indicating that its performance can not be predicted. Sakha 104 rice cultivar was identified as suitable genotype for unfavorable environments (low nitrogen and/or wide spacing) as indicated by its low b values (b = 0.83). The determination ratio (r^2) for the 6 genotypes ranged from 0.80 for IR64608B to 0.95 for IR68884A × Suweon 287R, indicating that there were differences in the stability of genotypes for their sterility percentages.

When the proportion of the genotype effects in the genotype × environment interaction was estimated (ecovalence index w); Sakha 104 exhibited the lowest value (7.56) followed by IR68884A × Suweon 287R (11.17), IR64608A × IR35366-62-1-2-2-3R (11.89), IR64608A × Suweon 287R (15.64), IR64608B (15.72) and IR67701A × IR35366-62-1-2-2-3R (16.72). In this concern, Sarkar *et al* (2003) studied the stability of sterility percentage in hybrid rice. They found that fertility restoration in hybrids from different CMS lines was highly sensitive to the changes in the environment. Hybrids PRH 21, PRH 16, PRH 22 and PRH 6 along with the controls IR64, Pusa 44 and Jaya possessed high S^2d values and regression coefficients more than unity (b>1). Their results indicated the specificity of the hybrids to various environmental conditions. In the present study, simultaneous considerations of all the parameters (X, b, S2di, r^2 and w) showed that Sakha 104 rice cultivar gave the lowest mean sterility percentage (9.39%), S2di value close to zero, high coefficient of determination (0.90) and the lowest ecovalence index (7.56) but had significant regression coefficient (b) value. So, it seems difficult to find a genotype fitting all the requirements for stability of sterility percentage under different nitrogen levels and plant spacing, but some can fit more measures than the others and have a sterility percentage below grand mean and can be accepted as stable. Thus, stability is a relative concept.

Filled grains/panicle

The results of no. filled grains/panicle in Table (2) indicated large variations in the regression coefficients (b) on the environment showing different responses of the genotypes to the environmental variations. The regression coefficient (b) values for this trait ranged from 0.691 for Sakha 104 cultivar to 1.391 for IR64608B line. These variations in (b) values suggested that the 6 genotypes responded differently for this trait to the different environments. The (b) values did not significantly differ from unity for all genotypes except Sakha 104 cultivar that showed highly significant b value (b = 0.691). Also deviations from regression S2di were insignificantly different from zero for two rice hybrids; IR64608A × IR35366-62-1-2-2-3R and IR67701A × IR35366-62-1-2-2-3R along with Sakha 104 cultivar. So, two hybrid genotypes namely; IR64608A × IR35366-62-1-2-2-3R and IR67701A × IR35366-62-1-2-2-3R satisfied the Eberhart and Russell (1966) requirements for being stable for filled grains/panicle.

Also, when the ecovalence (w); contribution of each genotype to the genotype × environment interaction (Wricke 1962) was computed for this trait, the ecovalence index (w) values ranged from 182.5 for IR67701A × IR35366-62-1-2-2-3R to 1077.8 for IR64608A × Suweon 287R. These results indicated that the (w) estimate as an index of stability which represent the proportion of the entry × environment sum of squares attributed to each genotype, varied among genotypes. IR64608A × IR35366-62-1-2-2-3R showed the lowest estimate for w (176.0). Thus, the stability of any genotype is inversely proportioned with (w) index (Nguyen *et al* 1980), where, coefficient of determination (r^2) is considered as an effective measure of stability. The two rice hybrids IR64608A × IR35366-62-1-2-2-3R and IR67701A × IR35366-62-1-2-2-3R showed high r^2 values (0.852 and 0.846, respectively), ensuring stability for filled grains/panicle.

Putting all studied parameters into account; IR67701A × IR35366-62-1-2-2-3R could be considered was the most stable genotype, whereas, Sakha 104 rice cultivar was identified as a suitable genotype for unfavorable environments as indicated by its low b value of 0.691 (highly significant) for this trait.

Table 2. Averages of genotypes and estimates of stability parameters for panicles/plant, sterility percentage, filled grains/panicle and 1000-grain weight across 18 environments.

Genotypes		Panicles/plant					Sterility percentage					Filled grains/panicle					1000-grain weight				
		Mean X	b	S^2d	r^2	w	Mean X	b	S^2d	r^2	w	Mean X	b	S^2d	r^2	w	Mean X	b	S^2d	r^2	w
IR64608A×IR35366- 62-1-2-2-3R		17.65	0.854	0.858	0.72	24.9	19.33	1.208^{+}	0.42**	0.93	11.89	177.42	1.04	6.64	0.852	176.0	23.56	1.502^{++}	0.092**	0.845	3.5
IR64608A×Suweon 287R		15.66	0.836	1.272*	0.69	32.1	20.75	1.166	0.73**	0.88	15.64	189.83	0.931	61.82**	0.426	1077.8	28.52	-0.438^{+}	1.14**	0.042	27.9
IR68884A×Suweon 287R		15.31	1.313^{+}	0.477	0.91	26.3	14.87	1.253^{++}	0.28**	0.95	11.17	189.37	0.919	19.84**	0.660	407.6	26.71	2.207^{++}	0.22**	0.842	10.7
IR67701A×IR35366- 62-1-2-2-3R		16.81	1.077	2.95**	0.66	57.0	23.86	0.658^{++}	0.48**	0.80	16.72	157.15	1.035	6.07	0.846	182.5	25.40	1.249	0.75**	0.346	13.4
Sakha 104		14.85	1.032	0.808	0.82	22.2	9.39	0.830^{+}	0.22	0.90	7.56	155.48	0.691^{++}	3.90	0.752	217.0	25.88	1.362	0.26**	0.638	5.7
IR64608 B		14.66	0.889	0.004	0.89	10.4	13.44	0.877	0.79**	0.80	15.72	169.77	1.391	32.41**	0.747	743.1	28.04	0.603	0.78**	0.110	14.2
Grand mean		15.82					17.77					173.17					26.35				
L.S.D.	0.05	0.94					0.49					3.07					0.16				
	0.01	1.33					070					4.36					0.23				

+, ++ = indicates regression coefficient is significantly different from unity at 5% and 1% levels of probability, respectively.
*, ** = indicates deviation from regression is significantly different from zero at 5% and 1% levels of probability, respectively.
b = Regression coefficient
r^2 = Coefficient of determination
w = Ecovalence

Panicles/plant

The mean, regression coefficient (b) on the environment and the deviation from regression S^2d_i of number of panicles/plant are presented in Table (2). The value of (b) was different for different genotypes, indicating their differential response to changed environments. Three genotypes showed regression coefficients (b) not significantly different from unity (b = 1) and deviation from regression S^2d_i not different from zero showing stability for this trait according to Eberhart and Russell (1966). Among them only one hybrid; IR64608A × IR35366-62-1-2-2-3R had mean performance above grand mean of this trait, showing the best stability under different nitrogen levels and plant spacing. The other two genotypes; Sakha 104 and IR64608B showed regression coefficients (b) not different from unity and deviations from regression S^2d_i close to zero but their mean no. of panicles/plant was 14.85 and 14.66, respectively below the grand mean of this trait. The other genotypes were not stable as they did not fit the concept.

The results of this trait showed that the line IR64608B recorded the lowest (w) value (10.4) followed by Sakha 104 cultivar (22.2) and the hybrid IR64608A × IR35366-62-1-2-2-3R (24.9) expressing stability. Thus, the stability of any genotype was inversely propertied with (w) value. The determination ratio (r^2) ensured stability of IR64608A × IR35366-62-1-2-2-3R, Sakha 104 and IR64608B for No. panicles/plant. On the other side, high regression coefficient (b = 1.313) of the hybrid IR68884A × Suweon 287R for this trait indicated that it may be suitable for highly favorable conditions (rich nitrogen environment combined with narrow plant spacing). Similar results were obtained by Peng *et al* (1991) who found highly variable heritability under different levels of nitrogen fertilization.

1000-grain weight

The results in Table (2) concerning 1000-grain weight indicated large variations in regression coefficients (b) on the environment, indicating that the genotypes showed different reactions to changed environments. The regression coefficient values (b) for this trait ranged from –0.438 for the hybrid IR64608A × Suweon 287R to 2.207 for the hybrid IR68884A × Suweon 287R.

Three genotypes viz., IR67701A × IR35366-62-1-2-2-3R, Sakha 104 and IR64608B showed regression coefficient (b) values near unity. So, these genotypes were stable for this trait as they fitted the Finaly and Wilkinson (1963) concept. Meanwhile. not all genotypes fitted the Eberhart and Russell (1966) concept of stability for this trait; however, IR64608A × Suweon 287R rice hybrid beside line IR64608B had a mean 1000-grain weight of 28.52 and 28.04g.i.e higher than that of the grand mean, respectively. These results indicated that the best performing, genotype was not necessary be the best stable genotype; in any trait., The r^2 values for this trait varied from 0.11 for line IR64608B to 0.845 for hybrid IR64608A × IR35366-62-1-2-2-3R, indicating real differences in the stability of genotypes. When the proportion of the genotype effects in the genotype × environment interaction was estimated (ecovalence index, w) for each genotype the hybrid IR64608A × IR35366-62-1-2-2-3R showed the lowest value (3.5) followed by the cultivar Sakha 104 (5.7) , then IR68884A × Suweon 287R (10.7) for this trait. Fayed (2004) reported that among 64 only two genotypes; Pino 4 and Rehio showed stability for 1000-grain weight.

Grain yield

The results regarding grain yield in Table (3) indicated large variations in regression coefficient (b) values on the environment showing different responses of the genotypes to the environmental variations. Four genotypes exhibited (b) values near unity, reflecting their yield stability (Finlay and Wilkinson 1963). However, among these four genotypes, two hybrids; IR64608A × IR35366-62-1-2-2-3R and IR64608A × Suweon 287R showed high mean grain yield with low coefficient of variations supporting their stability (Francis and Kannenberg 1978), see figure 1. The deviation from regression S^2d_i values were significantly deviated from zero for all genotypes. So, none of the genotypes satisfied the Eberhart and Russell (1966) requirements for being stable for grain yield i.e., regression coefficient (b) statistically equaled the unity and deviation from regression S^2d_i was close to zero.

The hybrid rice IR64608A × IR35366-62-1-2-2-3R recorded the highest r^2 value (0.86) followed by IR68884A × Suweon 287R (0.84) while, IR64608A × Suweon 287R showed the lowest value (0.72), indicating real differences in the stability of genotypes. The genotypes were divided into four groups according to their mean grain yield and coefficients of variability (CV%), The 1st group (IR64608A × IR35366-62-1-2-2-3A and IR64608A × Suweon 287R) showed high yield and low CV% (stability), the 2nd group (IR68884A × Suweon 287R) exhibited high yield and high CV% (instability), the 3rd group (Sakha 104 and IR64608B) showed low yield beside low CV% (stability) and the 4th group (IR67701A × IR35366-62-1-2-2-3R) disclosed low yield and high CV% (instability) , see Fig. 1.
1, 2, 3, 4, 5 and 6 are genotypes' numbers as mentioned in Table 3.

The ecovalence index (w_i) for grain yield trait is presented in Table (3). IR64608A × IR35366-62-1-2-2-3R recorded the lowest w value (0.44) thus; the stability of a genotype for grain yield was inversely proportional with w value (Nguyen *et al* 1980).

Table 3 Mean grain yield of genotypes (t/fed.), estimates of stability parameters, ranking and superiority across 18 environments

Genotypes	Mean	bi	S^2d_i	r^2	w	Yield rank	Rank sum			Superiority based on 18 environment (pi)
							1	2	3	
1- IR64608A×IR35366-62-1-2-2-3R	4.46	0.98	0.027**	0.86	0.44	2	5	3	6	0.05
2- IR64608A×Suweon 287R	4.61	1.05	0.075**	0.72	1.21	1	5	7	11	0.02
3- IR68884A×Suweon 287 R	4.20	1.04	0.035**	0.84	0.57	3	8	7	12	0.16
4- IR67701A×IR35366-62-1-2-2-3R	3.90	1.25^{+}	0.057**	0.83	1.09	4	10	9	15	0.39
5- Sakha 104	3.81	0.88	0.027**	0.83	0.48	5	7	7	9	0.43
6- IR64608 B	3.79	0.81^{+}	0.028**	0.81	0.55	6	7	9	10	0.45
Grand mean	4.13									
L.S.D.	0.05	0.06								
	0.01	0.08								

Index 1 based on yield rank + b rank, index 2 based on yield rank + S^2di rank and index 3 based on yield rank + b rank + S^2di rank.

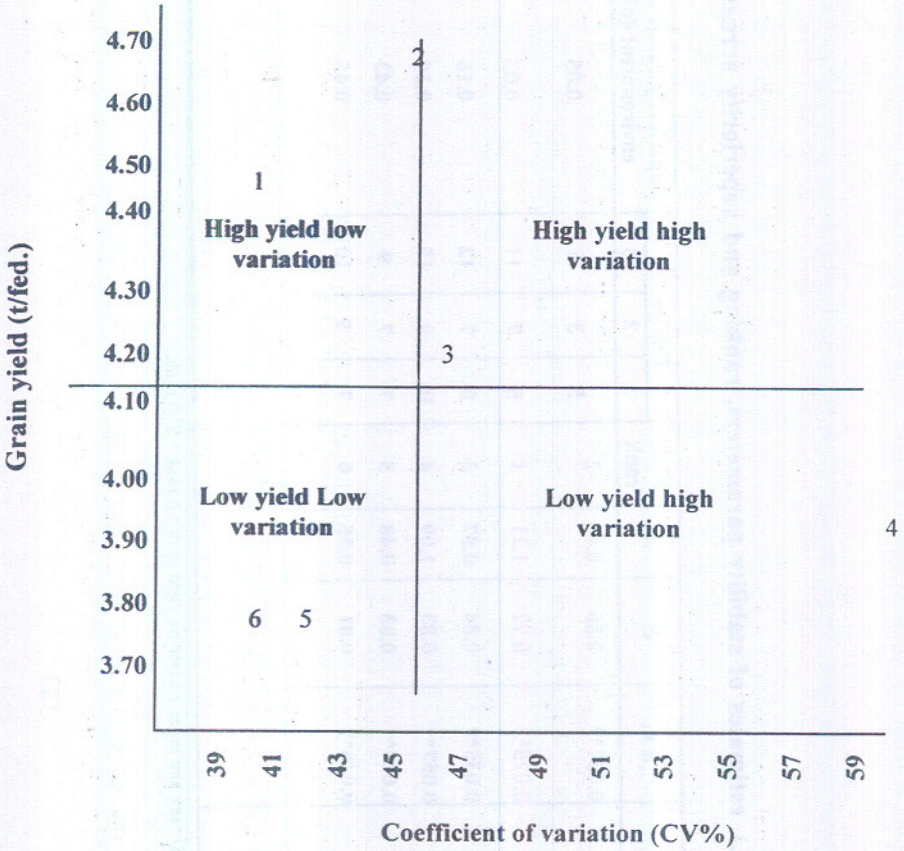

Fig. 1. A relation between grain yield and CV% as a stability measure (Francis and Kannenberg 1978)

The mean squares of distance between the cultivar and the maximum response; superiority (p_i); last column in Table (3); according to Lin and Binns (1988); indicated that IR64608A × IR35366-62-1-2-2-3R and IR64608A × Suweon 287R gave the lowest (p_i) value for this trait, supporting their stability for grain yield.

So, it seems difficult to find a genotype fitting all the requirements for grain yield stability under different nitrogen levels and various plant densities, but some can fit more measures than others and gave mean grain yield above the grand mean. So, they can be accepted as stable. Thus, yield stability is a relative concept. Similar results were mentioned By Liang *et al* (1989), Hasegawa *et al* (1991), Geetha *et al* (1994) and Manuel *et al* (1997).

However, Hildebrand (1990) suggested that the breeders should search for materials that are able to maintain productivity in poor environments or that excel in superior environments, rather than choosing material with regression coefficients equal unity. The later would produce less in poor environments than those with low regression, and also produce less in favorable environments than those with higher regression coefficients.

Large variations among the tested genotypes in their response to nitrogen application and spacing were detected: IR64608A × Suweon 287R showed significant higher grain yield under the highest nitrogen level. So, it may get further improvement for its grain yield under increased level of nitrogen.

The hybrid IR64608A × Suweon 287R recorded the highest no. filled grains/panicle, 1000-grain weight and grain yield. Environments + genotype × environment (linear) as well as pooled deviation effects were highly significant for most traits.

Stability measures showed that the hybrids IR64608A × Suweon 287R and IR64608A × IR35366-62-1-2-2-3R were the most stable genotypes for grain yield. Further, they are well adapted to all environments as indicated by insignificant (bi) values (b = 1) and gave higher grain yield than the overall mean. While, Sakha 104 rice cultivar was poorly adapted to all environments and IR67701A × IR35366-62-1-2-2-3R rice hybrid had a specific adaptability to favorable environments only. Simultaneous considerations of b, r^2 and w beside $\bar{x}$ (better than the grand mean) showed that the following genotypes may be considered the most stable for specific traits as follows:

Traits	**Genotypes**
Fertility percentage	**IR64608B** **Sakha 104**
No. of filled grains/panicle	**IR64608A × IR35366-62-1-2-2-3R**
No. of panicles/plant	**IR64608A × IR35366-62-1-2-2-3R**
1000-grain weight	**IR64608A × IR35366-62-1-2-2-3R** **Sakha 104**
Grain yield	**IR64608A × Suweon 287R** **IR64608A × IR35366-62-1-2-2-3R**

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ثبات هجن الآرز الهجين في بيئات متغيرة

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أجريت هذه الدراسة بقسم المحاصيل بكلية الزراعة بكفرالشيخ – جامعة طنطا وقد أجريت التجارب الحقلية أثناء مواسم 2001، 2002، 2003 بمزرعة الكلية – ويهدف هذا البحث الى دراسة ثبات بعض التراكيب الوراثية من الأرز الهجين.

واستخدم فى هذه الدراسة أربع هجن من ألأرز وسلالتين أحداهما ألصنف جيزه 104، والثانيه سلاله حافظه للسلاله ألعقيمة السيتوبلازم. تمت زراعة التراكيب ألوراثيه تحت مستويت من التسميد لأزوتي(25، 50، 75 كجم اَزوت للفدان) و ثلاث مسافات زراعه شتلا (20×15 ، 20×20، 20×25 سم)، ويمكن تلخيص أهم النتائج المتحصل عليها فيما يلى :

1. كانت الإختلافات بين التراكيب الوراثية عالية المعنوية لجميع الصفات المدروسة.
2. سجل الهجين IR64608A × Suweon 287R أعلى القيم لوزن الآلف حبه، عدد الحبوب الممتلئة/دالية وكذلك محصول الحبوب كمتوسط عام تحت جميع مستويات التسميد ومسافات الشتل.
3. كان التفاعل الخطى G × E (linear) وكذلك تباين الجزء الراجع للإنحراف عن خط الإنحدار عالى المعنوية لمعظم الصفات تحت الدراسة.
4. إتضح من دراسة مقاييس الثبات والتفوق أن الهجين IR64608A × Suweon 287R وكذلك الهجين IR6408A × IR35366-62-1-2-2-3R أفضل الهجن من ناحية الثبات. ولهما قدرة عالية على الأقلمة تحت جميع البيئات فى حين أظهر الصنف سخا 104 قدرة ضعيفة على الأقلمة فى جميع البيئات أما الهجين IR67701A × IR3566-62-1-2-2-3R فأظهر قدرة خاصة عالية على الأقلمة للبيئات الغنية.

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