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Yield Potential of Aromatic Rice Mutants/Varieties in Different Ecological Zones of Sindh

H. R. Bughio, A. M. Soomro, A. W. Baloch, M. A. Javed, I. A. Khan, M. S. Bughio, T. Mohammad and N. N. Mastoi
Nuclear Institute of Agriculture, Tandojam, Sindh, Pakistan

Abstract: Six rice mutants along with their parents and a check variety (Super Basmati) were evaluated at eight sites to determine genetic differences and the magnitude of genotype x environment interaction (G X E) for yield potential, in Sindh province. Genotype, location, year and their interactions were highly significant. The regression coefficient (b) and deviation from regression (S^2d) showed significant differences among the mutants/varieties. The mutants Bas. 20/1, Bas. 15/2, Bas. 15/14 and Sonahri Sugdasi-20 (SS-20) were superior in yield to all the entries under evaluation. On the basis of stability parameters, the mutants Basmati 20/1 and Basmati 15/14 have shown good adaptation potential under favourable as well as unfavourable environments.

Key words: Rice, mutants, regression coefficient (b), stability (S^2d)

Introduction

Rice (*Oryza sativa* L.) is one of the most important crops in Pakistan and the second largest contributor in export earnings after cotton (Qayyum *et al.*, 2000). The province of Sindh has varied ecological zones therefore; genotypes with wide adaptability are required to be identified which can perform consistently over a range of environments. Thus, estimation of stability of a new genotype for yield is a pre-requisite for its release as a commercial variety. Performance of a genotype in diverse environments is a true evaluation of its inherent potential for adaptiveness (Pandey *et al.*, 1981). Stability analyses on cultivar performance tests conducted under different environments have been reported by many researchers (Milligan *et al.*, 1990; Qayyum *et al.*, 2000 and Basford and Cooper, 1998). Crop stability, is the ability of a crop to exhibit minimum interaction with both predictable and unpredictable environments (Qayyum *et al.*, 2000). Eberhart and Russell's Model (1966) is one of the techniques used to rank the varieties for stability. The model uses simple linear regression to describe various types of varietal adoptabilities to wide range of environment as a quantitative measure of phenotypic stability.

Finlay and Wilkinson (1963) suggested that cultivar with regression coefficient (b) around 1.0 would be stable. Eberhart and Russell (1966) proposed regression coefficient (b) as the parameter of response and deviation from regression (S^2d) as the parameter of stability. The performance of crop plants varies in different environments, which indicates their adaptability to specific region or over wide areas. The objective of this study was, therefore, to estimate the stability and adaptability potential of aromatic rice mutants under different agro- climatic conditions in the province of Sindh.

Materials and Methods

Five promising aromatic rice mutants of Basmati 370 and one of Sonhari Sugdasi were developed at Nuclear Institute of Agriculture (NIA), Tandojam by using different doses of gamma rays and selected on the basis of high paddy yield. These mutants were evaluated along with their parent and check varieties viz. Basmati 370, Sonahri Sugdasi, Super Basmati in the province of Sindh at 8 different locations viz. Tandojam, Sanghar, Badin, Thatta, Dadu, RRI Dokri, Shikarpur and Jacobabad for two consecutive years. The experimental layout was RCB design with 4 replications at each site. Each genotype was sown in $15m^2$ plot with 25 rows, 3 meter long and 20 cm apart from each other.

Data were statistically analysed according to Steel and Torrie (1960). Stability parameters (b and S^2d) were estimated by using the methods described by Eberhart and Russell (1966).

Results and Discussion

The mean squares (MS) for genotypes, locations, years, location x year, location x genotype, year x genotype and year x location x genotype interactions were significant ($P \leq 0.01$) for paddy yield (kg ha^{-1}) (Table 1). Significant genotype x environment (G x E) interaction indicated the presence of genetic variability and differential response of the genotypes to varying environments (Table 2). Significant ($P \leq 0.05$) differences were recorded among mutants for paddy yield. Mutants of Basmati 370 (Basmati 20/1, Basmati 15/2 and Basmati 15/14) and Sonahri Sugdasi (SS. 20) were significantly superior to all the entries. The highest paddy yield (kg ha^{-1}) was observed in Basmati 20/1 followed by Basmati 15/2, S.S. 20 and Basmati 15/14. The lowest yield was recorded in both the parents i.e., Basmati 370 and Sonahri Sugdasi. The mutants of Basmati viz., Basmati 20/1, Basmati 15/2 and Basmati 15/14 showed 119.7, 91.6 and 60.6% increase over the parent, respectively. On the other hand, mutants of Sonahri Sugdasi i.e., S.S.20 showed 63.8 increase over the parent. Mutants, Basmati 20/1, Basmati 15/2, Basmati 15/14 and S.S. 20 showed 57.5, 37.4, 15.2 and 18.5% increase over check variety, Super Basmati.

Table 1: Pooled analysis of variance for paddy yield (kg ha^{-1}) of 9 aromatic rice mutants/varieties grown over 8 locations in Sindh during 1997 and 1998

Parameters	d.f	MS	F value	Probability
Year (Y)	1	16.4631**	686.10	0.000
Error (a)	3	00.10 ns	---	--
Location (L)	7	00.921**	18.77	0.000
Y x L	7	03.082**	62.82	0.000
Error (b)	42	00.049	---	--
Genotype (G)	8	60.6211**	1298.22	0.000
Y x G	8	01.735**	37.15	0.000
L x G	56	00.307**	6.57	0.000
Y x L x G	56	00.403**	8.64	0.000
Error (c)	384	00.047	---	--

MS = Mean square; ** = Significance at 1% level

Traditional analysis of variance procedures are useful in determining the presence of genotypes x environment interactions, but generally do not provide informations concerning genotypic stability (Norden *et al.*, 1986) . Regression coefficient (b) is a measure of stability in crop plants (Finlay and Wilkinson, 1963). Other researchers (Eberhart and Russell, 1966; Paroda and Hayes, 1971; Bughio *et al.*, 2000; Norden *et al.*, 1986) have suggested that regression coefficient (b) and deviation from regression coefficient (S^2d) may be taken into consideration in identifying a stable genotype. Regression coefficient (b) values for

Table 2: Pooled mean performance for paddy yield (kg/ha) of 9 aromatic rice mutants /varieties grown over 8 locations for 2 years (1997 and 1998)

Locations	Bas. 370 P	Bas. EF5	Bas. 15/2	Bas. 15/14	Bas. 20/1	Bas. 30/1	S.S. P	S.S. 20	Super Bas. check	Mean
Tandojam	1634c	1904c	2958ab	2575abc	3318a	2321bc	1698c	2554abc	2278bc	2360
Sangher	1714ef	2021def	3448ab	2501cd	3752a	2384bc	1551f	2632cd	2342cde	2482
Badin	1704de	2218cde	3335ab	2814bc	4045a	2258bcd	1334e	2605bc	2315bcd	2397
Thatta	1380f	2014e	3188b	2558c	3925a	2588d	1555f	2882c	2555d	2633
Dadu	1647e	1941de	2891ab	2515bcd	3341a	2395bcd	1611e	2598bc	2225cde	2351
RRI Dokri	1654d	2141cd	3011ab	2475bc	3541a	2221cd	1695d	2642bc	2211cd	2399
Shikarpur	1694e	2184cde	3198ab	2711bc	3552a	2495cd	1921d	2745bc	2208cde	2523
Jacobabad	1774f	2131def	3271abcd	3068abc	3535a	2688bcde	1955ef	3162ab	2278cdef	2651
Mean	1650	2069	3162	2652	3626	2418	1665	2727	2301	2474

Means with different letters differ significantly at $P \leq 0.05$

Table 3: Regression coefficient 'b' and variance due to deviation from regression for paddy yield (kg ha^{-1}) of 9 aromatic rice mutants/varieties grown over 8 locations for 2 years (1997-98)

Aromatic rice mutant/ varieties	Mean paddy yield (kg ha^{-1})	b ± S.E	S^2d
Bas. 370 (Parent)	1650	1.577±1.612	0.0079
Bas. EF-5	2069	0.804±0.320	0.0644
Bas. 15/2	3162	1.225±0.529	0.0270
Bas. 15/14	2652	0.932±0.675	0.0350
Bas. 20/1	3626	1.032±0.879	0.0050
Bas. 30/1	2418	1.403±0.335	0.0160
S.S. Parent	1665	0.815±0.695	0.030
S.S. 20	2727	1.631±0.379	0.0115
Super Bas	2301	0.565±0.159	0.1080

Bas. Basmati

mutants Basmati 20/1, Basmati 15/2, Basmati 15/14 and S.S. 20 value 1.577, which indicates that Basmati 370 is not well adapted in all the environments while Sonahri Sugdasi parent showed (b) value 0.815, which exhibits that Sonahri Sugdasi parent is well adapted in all the environments. Results revealed that mutation has induced positive changes in the adaptiveness and improves the yield potential of basmati mutants (Table 2). The maximum mean paddy yield was observed in Basmati 20/1. The deviation from regression coefficient (S^2d) close to zero was observed in case of Basmati 20/1 followed by the parent Basmati 370 (Table 3). The check, Super Basmati showed 0.565 (b) value and (S^2d) was 0.1080, respectively. A cultivar with (b) value less than 1.0 has above average stability and is specially adapted to low-performing environments, a cultivar with (b) value greater than 1.0 has below average stability and is specially adapted to high performing environments and a cultivar with (b) value equal to 1.0 has average stability and is well or poorly adapted to all environments depending on having a high or low mean performance (Finlay and Wilkinson, 1963), but a cultivar with $b = 1.00$ and $S^2d = 0.00$ may be defined as stable (Eberhart and Russell, 1966; Francis and Kannenberg, 1978; Qayyum *et al.*, 2000). On the basis of high paddy yield performance and estimates of stability parameters, it may be concluded that mutants Basmati 20/1 and Basmati 15/14 have good adaptation potential under favourable as well as unfavourable environments and may become a part of rice varietal complex of Sindh.

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