*Available online at* www.ijpab.com

DOI: http://dx.doi.org/10.18782/2320-7051.4079

**ISSN: 2320 – 7051**

*Int. J. Pure App. Biosci.* **5 (4):** 892-908 (2017)

*Research Article*

International Journal of Pure & Applied Bioscience

OPEN ACCESS

# Studies on Stability Analysis for Grain Yield and its Attributes in Rice (*Oryza sativa* L.) Genotypes

**Sriram Ajmera[1*], S. Sudheer Kumar[2] and V. Ravindrababu[3]**

[1]Scholar, [2]Professor

Department of Genetics and Plantbreeding, College of Agriculture, PJTSAU, Rajendranagar, Hyderabad

[3]Director, Indian Institute of Rice Research, Rajendranagar, Hyderabad

*Corresponding Author E-mail: srinaik53@gmail.com

Received: 17.06.2017 | Revised: 27.06.2017 | Accepted: 29.06.2017

**ABSTRACT**

*The present investigation entitled "Studies on Stability Analysis for Grain Yield and Its Attributes in Rice (Oryza sativa L.) Genotypes" was undertaken with thirty seven rice genotypes including two checks at three different locations situated at different agro-climatic regions of TELANGANA viz., Directorate of Rice Research farm at ICRISAT, Medak (Central Telangana Zone), Regional Agricultural Research Station, Jagtial (Northern Telangana Zone) and Agricultural Research Station, Kampasagar (Southern Telangana Zone) for studying stability for eight characters viz., days to 50 per cent flowering, plant height, panicle length, number of productive tillers per plant, total number of grains per panicle, number of filled grains per panicle, 1000- grain weight and grain yield per plant. At three locations, the analysis of variance indicated significant variation among the genotypes for all the characters studied. The pooled analysis of variance indicated significant variation among the environments, genotypes and Genotype x Environment interaction for all the characters studied. The significance of genotype and environment interaction suggests that genotypes behaved differently in different environment. The thirty seven Genotypes showed significant differences for all the characters, when tested against pooled error and pooled deviation. It reveals that the selected genotypes are having significant variation for all characters and may not showing uniform performance in different environments. Environments showed highly significant differences for all the characters under study except thousand grain weight, when tested against pooled error and panicle length and 1000 grain weight showed no significant differences, when tested against pooled deviation. It reveals that wide difference between environments. Whereas, Genotype x Environment interaction components showed highly significant differences for all the characters, when tested against pooled error and days to 50% flowering, plant height, total number of grains per panicle, and 1000 grain weight showed significantly differences, when tested against pooled deviation. It indicates wide differential behavior of genotypes in changing environments. The environment + (Genotype x Environment) was significant for all the characters, when tested against pooled error and all the characters shown significant differences except panicle length, number of filled grains when tested against pooled deviation.*

**Cite this article:** Ajmera, S., Kumar, S.S. and Ravindrababu, V., Studies on Stability Analysis for Grain Yield and its Attributes in Rice (*Oryza sativa* L.) Genotypes, *Int. J. Pure App. Biosci.* **5(4):** 892-908 (2017). doi: http://dx.doi.org/10.18782/2320-7051.4079

*It is indicating distinct nature of environments and genotype x environment interactions in phenotypic expression. Significance of Environment (linear) component for all the characters, when tested against pooled error and panicle length, and 1000 grain weight showed no significant differences, when tested against pooled deviation. It's indicating that difference between environments and their influence on genotypes for expression of these characters.The Genotype x Environment (linear) interaction was significant for all characters except panicle length, when tested against pooled error, while it was significant for days to 50% flowering, plant height and 1000 grain weight when tested against pooled deviation showed the significant differences. This indicated significant differences among the genotypes for linear response to environments (bi) behavior of the genotypes could be predicted over environments more precisely and G X E interaction was outcome of the linear function of environmental components. Hence, prediction of performance of genotypes based on stability parameters would be feasible and reliable. The significant pooled deviations for all characters, when tested against pooled error, indicates that the performance of genotypes is entirely unpredictable in nature. Among the genotypes studied, the genotypes RPHP104 and RPHP 107 were identified as the best genotypes at three locations, as they recorded highest mean for grain yield per plant with highest 1000 grain weight, number of productive tillers per plant and highest number of filled grains per panicle. Among the genotypes studied for the stability analysis at three locations, the genotype RPHP 103 and RPHP 104 showed stable performance for grain yield. The genotype RPHP 106 showed stable performance for grain yield, total number of grains per panicle and panicle length based on Eberhart and Russell (1966) stability criteria.*

***Key word:*** *Oryza sativa, Crop, Genotype, Environment.*

## INTRODUCTION

Rice, *Oryza sativa* (2n = 24) is the second most important cereal crop and staple food for more than one third of the world's population. Varietal adaptability to environmental fluctuations is important for the stabilization of crop production over both the regions and years. An information on genotype x environment interaction leads to successful evaluation of stable genotype, which could be used for general cultivation. Yield is a complex quantitative character and is greatly influenced by environmental fluctuations; hence, the selection for superior genotypes based on yield per se at a single location in a year may not be very effective. Thus, evaluation of genotypes for stability of performance under varying environmental conditions for yield has become an essential part of any breeding programme. An understanding of the causes of genotype x environment interaction can help in identifying traits and environments for better cultivar evaluation. For developing stable varieties, some stability parameters for which Finlay and Wilkinson (1963), Eberhart and Russell (1966) have given some models and have been used in the search for an understanding of the causes of G x E interaction. Development of rice hybrids with high yield and desirable grain quality for different environments is one of the exciting research leads to successful evaluation of stable genotype, which could be used for general cultivation. Therefore, the present investigation was carried out, identifying stable genotypes with high yield using Eberhart and Russell model.

## MATERIAL AND METHODS

The experiment was laid out in a Randomized Block Design (RBD) with three replications. The nursery was sown in raised beds and healthy nursery was raised at all the locations following uniform package of practices. Thirty days old seedlings were transplanted following a spacing of 20 x 15 cm with a row length of 4.5 m for each entry.

A set of 35 rice entries, along with two checks were analyzed for grain yield ant its attributes at the three loactions: Agricultural

Research Station, Kampasagar, Nalgonda district.Location II: Regional Agricultural Research Station, Jagtial, Karimnagar district.Location III: DRR farm, ICRISAT, Patancheru, Medak. during rainy (*kharif*) season of 2013. The genotypes were planted in a randomized block design (RCBD) with three replications following a spacing of 20 x 15 cm with a row length of 4.5 m for each entry.

The analysis of variance for each location was conducted the mean genotypic values for each location was taken for analyzing the data over location. The characters which recorded significant G X E were used for stability analysis of Eberhart and Russell model (1966). A genotype with unit regression coefficient ($b_i$=1) and deviation not significantly different from zero ($S^2d_i$=0) was taken to be a stable genotype with unit response.

## RESULTS AND DISCUSSION

The present investigation was carried out to evaluate thirty seven genotypes in three locations *viz*., Directorate of Rice Research farm at ICRISAT, Medak for Central Telangana Zone, Regional Agricultural Research Station, Jagtial, Karimnagar for Northern Telangana Zone and Agricultural Research Station, Kampasagar, Nalgonda for Southern Telangana Zone of Telangana state for the stability of the genotypes for grain Iron and Zinc concentrations, grain yield and yield related characters *viz*., days to 50 per cent flowering, plant height, panicle length, number of productive tillers per plant, total number of grains per panicle, number of filled grains per panicle, thousand grain weight and grain yield per plant. The results obtained are presented below under the following headings.

1 Analysis of Variance.

2 Stability parameters *viz.*, mean (μ), regression coefficient ($b_{i)}$ and deviation from regression ($S^2$di) as per Eberhart and Russell (1966) model.

### 1 ANALYSIS OF VARIANCE

Thirty seven rice genotypes including two checks (1702, 1708) obtained from Directorate of Rice Research, Hyderabad, were subjected to pooled analysis of variance for eight characters *viz*., days to 50 per cent flowering, plant height, number of productive tillers per plant, panicle length, number of filled grains per panicle, total number of grains per panicle, 1000–grain weight and Grain yield per plant. The analysis of variance (Table1) showed significant difference among the genotypes for all the characters studied in all the environments. It indicates that there is significant variation among genotypes, which can be further studied for their interaction with different environments to identify for their suitability for cultivation.

The pooled analysis of variance (Table2) indicated significant variation among the Environments, Genotypes and Genotype x Environment interaction for all the characters studied. The significance of Genotype and Environment interaction suggests that genotypes behaved differently in different environment. Similar kind of results earlier reported by Satya Priya Lalitha and Sreedhar[33], Chaudahari *et al.*[9], Shanmuganathan and Ibrahim34, Oikeh *et al.*[25], Velu *et al.*[42], Suwarto and Nasrullah[39] and Prasanna *et al*[29].

The genotype environment interactions was high for the characters plant height, total number of grains per panicle, number of filled grains per panicle and grain yield per plant suggesting that stratification of environments should be done to reduce the Genotype X Environment interaction.

### 2 STABILITY ANALYSIS

Rice is the staple crop and important cereal crop of India, being a thermo and photosensitive in nature, due to its buffering capacity it is being cultivated round the year in different agro-climatic zones of the country. However, the genotypes and breeding material likely to interact differently with different environments. The cultivated varieties and hybrids though having high yield potential, they are erratic in their performance even under less varied conditions of cultivation. Lack of genotypes suitable to specific locations accounts for the decline in the area and productivity in rice, apart from the biotic and abiotic stresses. This warrants the attention of the plant breeders to evolve superior genotypes that would sustain well in the strainful situation. Therefore, assessment of its adaptability is of important concern. Productivity of a population is the function of its adaptation, whereas stability is the statistical measure of genotype x environment interaction.

**2.1 Pooled analysis of variance**

The results of pooled analysis of variance for stability as devised by Eberhart and Russell (1966) are presented in Table: 3. The thirty seven genotypes showed significant differences for all the characters, when tested against pooled error and pooled deviation. It reveals that the selected genotypes are having significant variation for all characters. When tested against showing uniform performance in different environments. Significant differences among genotypes for these traits were earlier reported by Satya Priya Lalitha and Sreedhar[33], Chaudahari *et al.*[9], Shanmuganathan and Ibrahim[34].

Environments showed highly significant differences for all the characters under study except thousand grain weight, when tested against pooled error while panicle length and 1000 grain weight showed non significant variances, when tested against pooled deviation. It reveals that wide difference between environments. Significant differences due to environments for these traits were earlier reported by Satya Priya Lalitha and Sreedhar[33], Shanmuganathan and Ibrahim[34], Ali *et al.*[2], Pande *et al.*[26], Sanjay Singh and Singh[32], Bhakta and Das[7], Ahmad Ramezanil *et al.*[1], Lal and Pal Singh[21].

Whereas, Genotype x Environment interaction components showed highly significant differences for all the characters, when tested against pooled error. The Genotype X Environment interaction for days to 50% flowering, plant height, total number of grains per panicle and 1000 grain weight showed significantly differences, when tested against pooled deviation. It Indicates wide differential behavior of genotypes in changing environments, Suman Kumari *et al.*[38], Chaudhari *et al.*[9], Kishore *et al.*[19], Babu *et al.*[4], Shanmuganathan and Ibrahim[34], Ali *et al.*[2], Arumugan *et al.*[3], Sanjay Singh and Singh[32], Bhakta and Das[7], Panwar *et al.*[28], Ramya and Senthilkumar[30], Somana *et al.*[35] and Tariku *et al.*[41] also reported the differential response of varieties due to G x E interaction.

The Environment + (Genotype x Environment) was significant for all the characters, when tested against pooled error and all the characters shown significant differences except panicle length and number of filled grains when tested against pooled deviation. It is indicating distinct nature of environments and genotype x environment interactions in phenotypic expression. Significance of Environment (linear) component for all the characters except when tested against pooled error and panicle length and 1000 grain weight showed no significant differences, when tested against pooled deviation. It indicates difference between the environments and their influence on genotypes for expression of these characters. The findings of Panwar *et al.*[28] and Das *et al.*[10] were in accordance with the present results.

The Genotype x Environment (linear) interaction was significant for all characters except panicle length, when tested against pooled error and tested against pooled deviation days to 50% flowering, plant height and 1000 grain weight showed the significant differences. This indicated significant differences among the genotypes for linear response to environments (bi) behavior of the genotypes could be predicted over environments more precisely and G X E interaction was outcome of the linear function of environmental components. Hence, prediction of performance of genotypes based on stability parameters would be feasible and reliable. The similar results confirmed the findings of Munisonnappa *et al.*[23], Das *et al.*[10] and Dushyantha Kumar *et al.*[12]; both linear and non-linear components were significant for productive tillers per plant, plant height, indicated the importance of both the components in determining the stability of these traits. These results were confirmed by Nayak *et al.*[24], Krishnappa *et al.*[20], Dushyantha kumar *et al*.[12] and Subudhi *et al*[37]. The significant pooled deviations for all characters, when tested against pooled error. It indicated that the performance of genotypes is entirely unpredictable in nature. The present results confirmed the earlier findings of Shanmuganathan and Ibrahim[34], Dushyanth kumar and Shadadshari[12] and Dushyantha Kumar *et al*[13]. It also indicated the importance of non-linear component in determining interaction of genotypes with environment.

**2.2 Stability parameters**

According to Eberhart and Russell (1966), a stable genotype is one which shows (i) high mean yield (ii) regression coefficient ($b_i$=1) equal to unity and (iii) a mean square deviation from regression ($S^2d_i$) near to zero. In interpreting the results of the present investigation, S²di was considered as the measure of stability as suggested by Breeze (1969), then the type of stability (measure of response or sensitivity to environment changes) was decided on the regression coefficient (bi) and mean values (Finlay and Wilkinson, 1963). If bi is equal to unity, a genotype is considered to posses average stability (The performance does not change with the change in environment) and is widely adaptable to different environments, if $b_i$ is more than unity, it is considered to posses less than average stability and is adaptable to favourable environments, if $b_i$ is less than unity, it is considered to posses more than the average stability and is adaptable to poor environments.

Estimation of stability parameters i.e., mean (µ), regression coefficient ($b_i$) and a mean square deviation from regression ($S^2d_i$) for the ten characters are furnished below character- wise.

**2.2.1 Days to 50 per cent flowering**

Evaluation of the genotypes for stability indicated that, for days to 50 percent flowering, genotypes, environment and both linear and non-linear components of G x E interaction were significant, when tested against polled error and pooled deviation. Similar results were reported by Honarnejad[18], Babu *et al*.[4], Krishnappa *et al*.[20] and Biswas *et al*[8].

Evaluation of the genotypes for stability parameters for the character days to 50 percent flowering revealed that for twenty three genotypes deviation from regression ($S^2d_i$) was non significant indicating that their performance can be predicted (Table4.1). Among the genotypes studied, the genotypes RPHP 7, RPHP 10, RPHP 37, RPHP 51 and RPHP 80 were identified as a stable genotypes which having low mean (µ) with regression coefficient ($b_i$) near 'unity' and non–significant deviation from regression ($S^2d_i$).

Genotypes RPHP-84 and RPHP 104 flowered in 102 and 99 days with regression coefficient ($b_i$) greater than 'unity' and non significant deviation from regression ($S^2d_i$) and are suitable for better environment.

For poor environment, the genotypes RPHP 48, RPHP 105 and RPHP 106 were exhibited low mean (µ) with regression coefficient less than 'unity' and non significant deviation from regression were suitable.

**2.2.2 Plant height (cm)**

Evaluation of the genotypes for stability indicated that for plant height in the present investigation, genotypes, environments and both linear and non-linear components of G x E interaction were found to be significant, when tested against pooled error and pooled deviation. Similar results were observed by Shanmuganathan and Ibrahim[34], Panwar[28], Nayak *et al*.[24], Dushyantha Kumar *et al.*[13] and Subudhi *et al*[37].

Evaluation of the genotypes for stability parameters for the character plant height revealed that for thirty two genotypes deviation from regression ($s^2d_i$) was non significant indicating that their performance can be predicted (Table 4.1). Among the genotypes studied, the genotypes RPHP 87 and RPHP 114 were identified as a stable genotypes, which having low mean (µ) with regression coefficient ($b_i$) near 'unity' and non–significant deviation from regression ($S^{-2}d_i$).

The genotypes RPHP 37 and RPHP 135 are having moderate height with regression coefficient ($b_i$) greater than 'unity' and non–significant deviation from regression

($S^{-2}d_i$) with predictable performance are advised for better environment.

The genotype RPHP 104 recorded a height of 138cm with regression coefficient less than 'unity' and non–significant deviation from regression hence it is suitable for resource scarce environments.

**2.2.3 Panicle length (cm)**

Evaluation of the genotypes for stability indicated that for panicle length in the present investigation, genotypes, environments (linear) components of G x E interaction were found to be significant, when tested against pooled error and genotypes showed significant, when tested against pooled deviation. Similar results were observed by Honarnejad[18], Babu *et al*.[4], Krishnappa *et al*.[20] and Biswas *et al*[8].

Evaluation of the genotypes for stability parameters for the character panicle length revealed that for thirty four genotypes deviation from regression ($s^2d_i$) was non significant indicating that their performance can be predicted (Table 4.2).

The stable genotypes identified for panicle length are RPHP 90, RPHP 105, RPHP 106, RPHP 107, RPHP 163 and RPHP 166 which recorded high mean (cm), unit regression coefficient ($b_i$) and non–significant ($S^2d_i$) deviation from regression and are considered as stable genotype for this trait.

The genotype RPHP 56 was suitable for poor environments, which recorded high mean (μ) and non–significant deviation from regression ($S^2d_i$), but regression coefficient (bi) was less than 'unity'.

**2.2.4 Number of Productive tillers per plant**

Genotypes, environment, E+ (G x E), and both components of G x E interaction were found to be significant for number of productive tillers per plant, when tested against pooled error and g x e was showed no significant when tested against pooled deviation It demonstrated that the genotypes responded differently to the variation in environmental conditions of locations. Significance of linear component was reported by Munisonnappa *et al*.[23], Shanmuganathan and Ibrahim[34], while significance of nonlinear component was reported by Babu *et al*[4].

Evaluation of the genotypes for stability parameters for the character number of productive tillers per plant revealed that for twenty five genotypes deviation from regression ($S^2d_i$) was non significant indicating that their performance can be predicted (Table 4.2). The genotype RPHP 107, RPHP 129 and RPHP 165 were recorded high mean (μ) with regression coefficient ($b_i$) 'unity' and non–significant ($S^2d_i$) deviation from regression and were considered as stable genotypes for this trait.

**2.2.5 Total number of Grains per panicle**

Evaluation of the genotypes for stability indicated that for total number of grains per panicle in the present investigation, genotypes, environments, both linear and non linear components of G X E were found to be significant, when tested against pooled error and pooled deviation. This indicated significant difference among the genotypes for linear response to environments, similar results were observed by Krishnappa *et al*.[20] and Biswas *et al.*[8] and non-linear components of G x E interaction were found to be no significant. Similar results were observed by Nayak *et al*.[24] and Babu *et al*[4].

Evaluation of the genotypes for stability parameters for the character total number of grains per panicle revealed that for twenty one genotypes deviation from regression ($S^2d_i$) was non significant indicating that their performance can be predicted (Table 4.3). The genotypes RPHP 92, RPHP 106 and RPHP 129 recorded high mean (μ), regression coefficient ($b_i$) near to 'unity' and non–significant ($S^2d_i$) deviation from regression and were declared as stable.

The genotype RPHP 37 were suitable for better environment as it recorded high mean (μ),with more than unit regression coefficient ($b_i$) and non–significant deviation from regression ($S^2d_i$).

The genotypes 1702 was suitable for poor environments, as it recorded high mean (μ) and non- significant deviation from regression

($S^2d_i$) but regression coefficient ($b_i$)) less than unity.

**2.2.6 Number filled of Grains per panicle**

Evaluation of the genotypes for stability indicated that for number of filled grains per panicle in the present investigation genotypes, environments and both components of G X E were found to be significant, when tested against pooled error, genotypes, environments and environment (linear) showed significant differences, when tested against pooled deviation. Similar results were observed by Honarnejad[18].

Evaluation of the genotypes for stability parameters for the character number of filled grains per panicle revealed that for seventeen genotypes deviation from regression ($S^2d_i$) was non significant indicating that their performance can be predicted (Table 4.3). Among the genotypes studied, the genotypes RPHP 165, RPHP 130 and 1702 were considered as stable because they were having high mean, unit regression coefficient and non–significant deviation from regression.

The genotypes RPHP 16, RPHP 105 and RPHP 52 were having moderate mean, regression coefficient greater than 'unity' and non–significant deviation from regression can perform well under favorable environment.

**2.2.7 1000- grain weight (g)**

Genotypes, Genotypes X Environment, (G + G X E) and G X E (linear) were showed significance for 1000-grain weight, when tested against pooled error and pooled deviation. It indicated significant difference among the genotypes for linear response to environments. Earlier similar kind of results was showed by Sreedhar *et al.*[36] and Saidaiah *et al*[31].

Evaluation of the genotypes for stability parameters for the character 1000 grain weight revealed that for thirty five genotypes deviation from regression ($S^2d_i$) was non significant indicating that their performance can be predicted (Table 4.4).

The genotypes RPHP 10, RPHP 37, RPHP 91, RPHP 92, RPHP 104, RPHP 129, RPHP 157, RPHP 165, 1702 and 1708 recorded high mean (µ), unit regression coefficient ($b_i$) and non-significant deviation from regression ($S^2d_i$) and were considered as stable for this trait.

The genotypes which exhibited high mean, regression coefficient more than 'unity' and non–significant deviation from regression and recommended for resource rich environments were RPHP 80 and RPHP 135.

The genotype RPHP 16 which is having high mean (µ) with regression coefficient (bi) less than 'unity' and non–significant deviation from regression ($S^2d_i$) was Suitable for poor environment,

**2.2.8 Grain yield per plant (g)**

Genotypes, environments and the Environment (linear) showed significance for this trait, when tested against pooled error but when tested against pooled deviation g x e was showed no significant differences. It indicated significant differences among the genotypes for linear response to environments. Earlier, Nayak[24], Biswas *et al.*[8] and Bhaktha *et al.*[7] reported similar kind of results and were of the opinion that performance could not predicted, when the location was changed.

Evaluation of the genotypes for stability parameters for the character grain yield revealed that for fifteen genotypes the deviation from regression ($S^2d_i$) was no significant differences indicating that their performance can be predicted (Table 4.4).

The genotypes RPHP 103, RPHP104, RPHP106 and RPHP 134 were considered stable as they recorded high mean (µ) with regression coefficient ($b_i$) near 'unity' and non–significant deviation from regression ($S^2d_i$).

The genotypes RPHP 107, RPHP 105 and RPHP 165 were recorded the highest grain yield per plant but they showed significant deviation from regression. These genotypes may be further tested to reduce the genotype environment interaction in location with similar conditions for identify a stable genotype for particular location.

Among the genotypes studied for the stability analysis at three locations, the genotype RPHP 103 and 104 showed stable performance for grain yield.The genotype RPHP 106 showed stable performance for grain yield, grain Iron content, total number of grains per panicle and panicle length. Fig: 4 Shows the stable genotypes RPHP 103, RPHP 104 and RPHP 106 with grain yield.

**Table 1: Location wise analysis of variance for Grain yield and yield contributing traits in rice (*Oryza sativa* L.) Genotypes**

| Character | Kampasagar | | | | Jagtial | | | | ICRISAT | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean sum of square | | | | Mean sum of square | | | | Mean sum of square | | | |
| | Replication | Treatments | Error | Total | Replication | Treatments | Error | Total | Replication | Treatments | Error | Total |
| df | 2 | 36 | 72 | 110 | 2 | 36 | 72 | 110 | 2 | 36 | 72 | 110 |
| Days to50% flowering | 1.00 | 162.80** | 3.04 | 55.2 | 2.33 | 346.62** | 2.14 | 114.89 | 18.27* | 359.67** | 4.52 | 121.002 |
| Plant height | 11.93 | 1608.00** | 49.26 | 558.71 | 690.66* | 1855.48** | 142.61 | 713.31 | 95.42 | 1471.04** | 55.89 | 519.75 |
| Panicle length | 6.37 | 8.67** | 2.13 | 4.35 | 3.62 | 37.18** | 15.61 | 22.45 | 2.48 | 20.33** | 0.85 | 7.26 |
| Number of Productive tillers per plant | 0.19 | 12.55** | 0.63 | 4.52 | 1.67 | 10.51** | 0.56 | 3.84 | 0.47 | 12.84** | 1.38 | 5.11 |
| Total number of Grains per panicle | 37.01 | 3610.84** | 41.47 | 1209.55 | 143.02 | 4696.30** | 99.95 | 1694.99 | 56.90 | 1901.63** | 57.24 | 660.85 |
| Number of filled Grains per panicle | 12.15 | 3174.23** | 72.10 | 1086.00 | 118.18 | 3152.78** | 131.24 | 1119.87 | 3.09 | 755.49** | 33.3 | 269.16 |
| 1000 Grain weight | 2.70 | 39.14** | 3.35 | 15.05 | 1.58 | 45.11** | 4.43 | 17.69 | 2.42 | 46.41** | 6.70 | 19.69 |
| Grain yield per plant | 1.97 | 17.10** | 0.78 | 6.17 | 0.83 | 308.05** | 6.28 | 104.94 | 4.789 | 147.59** | 3.96 | 50.98 |

* Significant at 5 per cent level of significance ** Significant at 1 per cent level of significance

**Table 2: Pooled analysis of variance for Grain yield and yield contributing traits in Rice (*Oryza sativa* L.) genotypes**

| Character | Replications within environments | Mean sum of squares | | | |
|---|---|---|---|---|---|
| | | Environments | Genotypes | Genotypes*Environment | Pooled error |
| df | 6 | 2 | 36 | 72 | 216 |
| Days to50% flowering | 2.40 | 1179.93** | 540.16** | 164.47** | 3.23 |
| Plant height | 88.68 | 2235.68** | 4271.89** | 331.30** | 82.67 |
| Panicle length | 1.38 | 25.77* | 40.39** | 12.90** | 6.20 |
| Number of Productive tillers per plant | 0.26 | 261.61** | 28.94** | 3.48** | 0.86 |
| Total number of Grains per panicle | 26.34 | 45098.23** | 7580.57** | 1314.11** | 66.22 |
| Number of filled Grains per panicle | 14.81 | 18092.71** | 4720.83** | 1180.86** | 78.91 |
| 1000 Grain weight | 0.74 | 9.20 | 102.53** | 14.06** | 4.83 |
| Grain yield per plant | 1.21 | 3874.85** | 508.37** | 111.06** | 4.34 |

*Significant at 5 per cent level of significance ** Significant at 1 per cent level of significance

**Table 3: Analysis of variance for Grain yield and yield components for stability in Rice (*Oryza sativa* L.) Genotypes**

| Source | df | Mean sum of squares | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | **Days to 50% flowering** | **Plant height** | **Panicle length** | **Number of productive tillers** | **Total number of grains per panicle** | **Number of filled grains per panicle** | **1000 grain weight** | **Grain yield per plant** |
| Genotypes | 36 | 180.05**@@ | 1423.96**@@ | 13.44**@@ | 9.64**@@ | 2656.85**@@ | 1573.61**@@ | 34.17**@@ | 169.45**@@ |
| Environments | 2 | 393.22**@@ | 745.18**@@ | 8.58** | 87.20**@@ | 15032.94**@@ | 6030.95**@@ | 3.06**@@ | 1291.62**@@ |
| Genotype X Environment | 72 | 54.82**@@ | 110.44**@@ | 4.30** | 1.16** | 438.03**@@ | 393.62** | 4.68** | 37.02** |
| Environment + (Genotype X Environment) | 74 | 63.97**@@ | 125.59**@@ | 4.41** | 3.48**@@ | 832.49**@@ | 545.98** | 4.64**@@ | 70.02**@ |
| Environment (linear) | 1 | 786.44**@@ | 1490.36**@@ | 17.17** | 174.41**@@ | 30065.89**@@ | 12061.90**@@ | 6.13**@@ | 2583.24**@@ |
| Genotype X Environment (linear) | 36 | 100.37**@@ | 171.53**@@ | 2.82 | 0.68** | 688.58**@@ | 365.96** | 8.09**@@ | 32.33** |
| Pooled deviation | 37 | 9.02** | 48.01** | 5.61** | 1.59** | 182.42** | 409.88** | 1.24 | 40.58** |
| Pooled error | 216 | 1.07 | 27.55 | 2.01 | .28 | 22.07 | 26.30 | 1.61 | 1.44 |

*, ** Significance at 5 percent and 1 percent level of significance respectively when tested against pooled error

@, @@ Significance at 5 percent and 1 percent level of significance respectively when tested against pooled deviation

**Table: 4.1 Mean performance and stability parameters for days to 50% flowering and plant height of Rice (*Oryza sativa* L.) Genotypes**

| S.No | Genotypes | Days to 50%flowering | | | Plant height(cm) | | |
|---|---|---|---|---|---|---|---|
| | | Mean | ßi | S²Di | Mean | ßi | S²Di |
| 1 | RPHP-7 | 87.00 | -0.29 | 1.76 | 113.5 | 0.92 | -29.2 |
| 2 | RPHP-10 | 87.11 | -0.54 | 0.95 | 101.7 | 0.65 | -10.9 |
| 3 | RPHP-16 | 101.33 | 1.02 | 0.82 | 137.2 | 1.90 | -22.2 |
| 4 | RPHP-21 | 104.22 | -0.40* | -0.99 | 110.1 | -0.19 | 26.7 |
| 5 | RPHP-37 | 86.22 | 0.09 | -0.35 | 105.8 | 4.23* | -27.7 |
| 6 | RPHP-45 | 89.33 | -0.38 | 6.59** | 99.9 | -0.92 | -24.4 |
| 7 | RPHP-48 | 86.22 | 0.25* | -1.04 | 119.0 | 4.76 | 196.2 ** |
| 8 | RPHP51 | 84.66 | -0.23 | -0.25 | 122.0 | -1.59 | 342.5 ** |
| 9 | RPHP-52 | 87.77 | -0.50 | 4.48* | 117.0 | 2.27 | -28.7 |
| 10 | RPHP-56 | 81.88 | -0.83 | 44.29 ** | 113.7 | 1.87 | -22.5 |
| 11 | RPHP59 | 87.55 | -0.85 | 19.35 ** | 95.7 | 0.31 | 14.5 |
| 12 | RPHP 80 | 84.66 | -0.38 | -0.73 | 131.4 | 1.14 | -6.3 |
| 13 | RPHP 81 | 105.33 | 3.63 | 1.31 | 119.7 | -0.62 | -3.6 |
| 14 | RPHP84 | 102.33 | 4.23* | -1.04 | 146.4 | 0.75 | 98.3 * |
| 15 | RPHP87 | 104.66 | 1.87 | 5.79 * | 86.8 | -1.42 | 2.2 |
| 16 | RPHP90 | 106.22 | 1.58 | 2.71 | 157.0 | -0.97 | 36.3 |
| 17 | RPHP91 | 103.66 | 1.73 | -0.71 | 148.2 | 1.84 | 57.8 |
| 18 | RPHP92 | 97.88 | 0.75 | 1.11 | 147.6 | 0.40 | -27.4 |
| 19 | RPHP 103 | 96.55 | 3.09 | 0.69 | 157.9 | -2.15 | -26.2 |
| 20 | RPHP 104 | 99.11 | 3.63* | -1.06 | 137.7 | -4.95* | -29.1 |
| 21 | RPHP 105 | 89.55 | -0.56* | -1.05 | 133.6 | 0.21 | -11.9 |
| 22 | RPHP 106 | 90.33 | -3.92* | 0.005 | 149.4 | 2.88 | 107.9 * |
| 23 | RPHP 107 | 100.44 | 3.94 | 0.72 | 147.5 | 0.91 | -25.8 |
| 24 | RPHP 108 | 101.00 | 3.86 | 5.04 * | 97.9 | -1.82 | 15.6 |
| 25 | RPHP 114 | 101.22 | 1.08 | 0.97 | 72.2 | 1.18 | -27.3 |
| 26 | RPHP 129 | 100.55 | 1.35 | -0.58 | 109.7 | -0.14 | -28.2 |
| 27 | RPHP 130 | 90.55 | -3.14 | 25.89 ** | 113.3 | 2.73 | -21.2 |
| 28 | RPHP 134 | 92.00 | -3.07 | 38.93 ** | 110.7 | 3.47 | -2.9 |
| 29 | RPHP 135 | 100.22 | 4.01 | 2.72 | 114.8 | 2.52* | -28.9 |
| 30 | RPHP 138 | 94.33 | 2.80 | 42.88 * | 103.0 | 3.348 | -26.3 |
| 31 | RPHP 157 | 98.00 | 3.32 | 5.03 * | 145.0 | 4.06 | 312.5 ** |
| 32 | RPHP 158 | 102.66 | 2.55 | 33.33 ** | 149.6 | 2.69 | -14.3 |
| 33 | RPHP 163 | 103.00 | 4.15 | 39.02 ** | 144.3 | 2.54 | 12.2 |
| 34 | RPHP 165 | 105.22 | 3.49 | 15.47 ** | 150.3 | 3.61* | -28.8 |
| 35 | RPHP 166 | 105.77 | 0.03 | 2.70 | 152.9 | 0.15 | 1.8 |
| 36 | 1702 | 108.77 | 2.49 | -1.69 | 126.0 | 0.48 | -28.9 |
| 37 | 1708 | 101.33 | 1.90 | 6.77 * | 124.2 | -0.10 | -25.9 |
| | G.M | 96.45 | | | 124.27 | | |
| | C.D | 8.02 | | | 17.12 | | |
| | C.V | 5.09 | | | 8.44 | | |
| | SEM | 2.12 | | | 6.07 | | |

**Table: 4.2 Mean performance and stability parameters for panicle length and number of productive tillers per plant of Rice (*Oryza sativa* L.) Genotypes**

| S.no | Genotypes | Panicle length (cm) | | | Number of Productive tillers | | |
|---|---|---|---|---|---|---|---|
| | | Mean | ßi | S²Di | Mean | ßi | S²Di |
| 1 | RPHP-7 | 27.35 | 4.61 | -1.41 | 10.56 | 0.88 | 1.29 * |
| 2 | RPHP-10 | 27.31 | 3.18 | -0.62 | 11.41 | 1.69 | 0.74 |
| 3 | RPHP-16 | 26.81 | 0.57 | 0.12 | 9.02 | 0.86 | 0.25 |
| 4 | RPHP-21 | 21.95 | -0.31 | -1.77 | 10.39 | 1.16 | 1.015 * |
| 5 | RPHP-37 | 21.97 | -2.41 | -0.44 | 11.06 | 0.68 | -0.27 |
| 6 | RPHP-45 | 24.17 | 0.41 | -2.04 | 9.20 | 0.87 | 1.46 * |
| 7 | RPHP-48 | 25.69 | 2.85 | -1.84 | 8.34 | 0.53 | -0.14 |
| 8 | RPHP51 | 26.97 | 1.1 | 1.56 | 8.97 | 1.11 | 0.79 |
| 9 | RPHP-52 | 27.35 | 1.23 | -0.32 | 10.01 | 0.73 | -0.28 |
| 10 | RPHP-56 | 26.53 | -2.27* | -2.02 | 8.43 | 1.26 | 0.96 * |
| 11 | RPHP59 | 26.31 | -2.56 | -0.82 | 9.48 | 0.99 | 0.35 |
| 12 | RPHP 80 | 26.24 | 2.16 | 0.09 | 11.00 | 1.68 | 0.77 |
| 13 | RPHP 81 | 24.39 | 2.96 | -1.93 | 8.78 | 1.04 | -0.24 |
| 14 | RPHP84 | 24.68 | 2.30 | -1.45 | 8.65 | 1.03 | -0.22 |
| 15 | RPHP87 | 22.66 | -3.36 | 14.07 ** | 6.78 | 0.99 | -0.23 |
| 16 | RPHP90 | 28.77 | 5.73 | 4.07 | 8.27 | 0.81 | -0.17 |
| 17 | RPHP91 | 26.80 | 2.62 | -0.36 | 11.50 | 0.62 | 2.31 ** |
| 18 | RPHP92 | 30.64 | 0.09 | 122.12** | 11.88 | 0.96 | -0.21 |
| 19 | RPHP 103 | 27.55 | 2.03 | -1.46 | 10.28 | 0.68 | -0.26 |
| 20 | RPHP 104 | 26.84 | -1.27 | -1.88 | 13.03 | 1.02 | 0.99 * |
| 21 | RPHP 105 | 28.83 | 3.96 | 5.62 | 9.15 | 0.49 | 1.95 ** |
| 22 | RPHP 106 | 30.53 | -0.05 | 0.11 | 11.91 | 0.77 | 0.67 |
| 23 | RPHP 107 | 28.50 | 4.92 | -1.5 | 14.02 | 1.28 | -0.26 |
| 24 | RPHP 108 | 23.80 | -0.12 | 4.80 | 7.91 | 1.35 | 0.05 |
| 25 | RPHP 114 | 24.15 | -2.24 | 1.20 | 7.48 | 0.92* | -0.28 |
| 26 | RPHP 129 | 24.95 | 0.95 | 2.12 | 12.33 | 1.29 | -0.25 |
| 27 | RPHP 130 | 24.57 | -0.51 | -1.52 | 10.55 | 0.82 | 0.30 |
| 28 | RPHP 134 | 24.50 | -2.41 | -1.83 | 11.71 | 0.79 | 1.12 * |
| 29 | RPHP 135 | 26.73 | -0.96 | -0.48 | 9.11 | 1.39 | 1.46 * |
| 30 | RPHP 138 | 26.11 | -2.34 | -0.24 | 9.22 | 0.52 | 0.48 |
| 31 | RPHP 157 | 26.11 | 2.12 | 0.12 | 11.16 | 0.52 | -0.15 |
| 32 | RPHP 158 | 26.86 | -1.11 | -2.03 | 6.41 | 0.27 | 0.39 |
| 33 | RPHP 163 | 28.53 | 1.83 | -1.66 | 10.10 | 1.70 | 13.46 ** |
| 34 | RPHP 165 | 27.88 | 3.08 | -1.74 | 12.41 | 1.79 | 0.02 |
| 35 | RPHP 166 | 29.44 | 5.72 | 0.43 | 7.12 | 0.86* | -0.28 |
| 36 | 1702 | 24.91 | 2.49 | -1.69 | 10.00 | 0.84 | 8.50 ** |
| 37 | 1708 | 27.13 | 1.90 | 6.77 * | 11.31 | 1.66 | 12.25 ** |
| | G.M | 26.39 | | | 10.41 | | |
| | C.D | 3.55 | | | 1.52 | | |
| | C.V | 8.28 | | | 9.21 | | |
| | SEM | 1.26 | | | 0.53 | | |

**Table: 4.3 Mean performance and stability parameters for Total number of grains per panicle and number of filled grains /panicle of Rice (*Oryza sativa* L.) Genotypes**

| s.no | genotypes | Total number of grains per panicle | | | Number of filled grains /panicle | | |
|---|---|---|---|---|---|---|---|
| | | Mean | ßi | S²Di | Mean | ßi | S²Di |
| 1 | RPHP-7 | 117.7 | 0.59 | -20.36 | 94.07 | 0.16 | -10.53 |
| 2 | RPHP-10 | 131.4 | 0.27 | 143.46 ** | 107.32 | 0.05 | 79.28 * |
| 3 | RPHP-16 | 103.0 | 1.28* | -21.85 | 84.40 | 1.942* | -25.98 |
| 4 | RPHP-21 | 118.9 | 0.64 | 10.64 | 90.50 | 0.20 | 145.99* |
| 5 | RPHP-37 | 126.6 | 1.46* | -22.23 | 95.12 | 1.25 | -17.80 |
| 6 | RPHP-45 | 103.8 | 1.52 | -3.41 | 89.78 | 2.49 | 35.44 |
| 7 | RPHP-48 | 95.2 | 1.27 | 26.87 | 76.15 | 1.45 | -19.40 |
| 8 | RPHP51 | 98.0 | 0.77 | -5.05 | 79.01 | 0.68 | 40.04 |
| 9 | RPHP-52 | 110.9 | 1.32 | -18.44 | 90.52 | 1.556* | -25.63 |
| 10 | RPHP-56 | 91.3 | 0.36 | 136.42 ** | 72.46 | 0.14 | 257.82 ** |
| 11 | RPHP59 | 94.1 | 0.36 | 270.72 ** | 78.85 | 0.50 | 275.00 ** |
| 12 | RPHP 80 | 124.5 | 0.36 | 231.23 ** | 98.80 | -0.28 | 269.52 ** |
| 13 | RPHP 81 | 101.3 | 0.99 | -18.14 | 82.95 | 1.07 | -18.36 |
| 14 | RPHP84 | 98.5 | 0.96 | -6.05 | 74.69 | 1.02 | 135.14* |
| 15 | RPHP87 | 68.8 | 0.85 | 262.45 ** | 50.64 | 0.81 | 1098.74 ** |
| 16 | RPHP90 | 95.4 | 0.86 | -14.04 | 81.66 | 1.55 | -3.16 |
| 17 | RPHP91 | 145.9 | 3.12 | 900.6 ** | 106.48 | 2.92 | 1769.06 ** |
| 18 | RPHP92 | 141.7 | 1.70 | 58.18 | 119.11 | 1.60 | 337.38 ** |
| 19 | RPHP 103 | 139.5 | 3.12 | 1781.20 ** | 97.72 | 2.05 | 135.09 * |
| 20 | RPHP 104 | 165.9 | 2.20 | 611.98 ** | 131.14 | 2.14 | 743.30 ** |
| 21 | RPHP 105 | 105.7 | 1.93* | -21.67 | 79.44 | 2.233* | -25.70 |
| 22 | RPHP 106 | 139.6 | 0.17 | 57.87 | 113.47 | -0.22 | 120.24 * |
| 23 | RPHP 107 | 197.0 | 1.47 | 78.9 * | 150.60 | 0.69 | 4020.99 ** |
| 24 | RPHP 108 | 90.3 | 0.69 | 91.85 * | 89.54 | 1.70 | 2978.63 ** |
| 25 | RPHP 114 | 82.1 | 0.98 | -1.36 | 69.51 | 1.41 | 135.38 * |
| 26 | RPHP 129 | 143.3 | 1.05 | -21.88 | 106.00 | 0.46 | 951.11 ** |
| 27 | RPHP 130 | 120.1 | 0.99 | -22.26 | 104.53 | 1.68 | 16.01 |
| 28 | RPHP 134 | 133.4 | 0.98 | 8.33 | 108.99 | 0.74 | 169.080** |
| 29 | RPHP 135 | 99.9 | 0.66 | 180.44** | 87.00 | 1.15 | -15.86 |
| 30 | RPHP 138 | 102.3 | 1.58 | 11.72 | 93.33 | 2.17 | 27.71 |
| 31 | RPHP 157 | 131.0 | 2.07 | 76.83 * | 99.27 | 1.88 | 34.91 |
| 32 | RPHP 158 | 74.5 | 1.46 | 16.77 | 61.85 | 1.93 | 64.42 |
| 33 | RPHP 163 | 123.1 | -2.01 | 103.88 * | 102.35 | -2.31 | 86.37 * |
| 34 | RPHP 165 | 155.6 | 0.43 | 574.68 ** | 118.70 | -0.15 | 42.88 |
| 35 | RPHP 166 | 72.2 | 1.003 | 248.7 0** | 64.86 | 1.47 | 143.13 * |
| 36 | 1702 | 171.0 | -0.43* | -21.30 | 155.58 | -0.70 | 21.50 |
| 37 | 1708 | 147.5 | -0.19 | 263.20 ** | 131.07 | -0.42 | 232.19 ** |
| | G.M | 118.19 | | | 95.60 | | |
| | C.D | 32.05 | | | 27.89 | | |
| | C.V | 16.6 | | | 17.7 | | |
| | SEM | 11.3 | | | 9.81 | | |

**Table: 4.4 Mean performance and stability parameters for Grain yield per plant and 1000 grain weight of Rice (*Oryza sativa* L.) Genotypes**

| S.no | Genotypes | 1000 grain weight(g) | | | Grain yield/plant(g) | | |
|---|---|---|---|---|---|---|---|
| | | Mean | ßi | S²Di | Mean | ßi | S²Di |
| 1 | RPHP-7 | 25.38 | 0.68 | -1.53 | 21.61 | 0.78 | 1.10 |
| 2 | RPHP-10 | 26.78 | 6.01 | -0.65 | 26.18 | 1.40 | 63.89 ** |
| 3 | RPHP-16 | 23.08 | -3.85* | -1.58 | 18.12 | 1.27 | 0.31 |
| 4 | RPHP-21 | 25.63 | 4.01 | -1.55 | 21.80 | 0.93 | 5.38 * |
| 5 | RPHP-37 | 26.56 | -0.50 | -1.58 | 24.61 | 1.36 | 14.74 ** |
| 6 | RPHP-45 | 23.55 | -4.97 | -0.23 | 18.65 | 1.42 | 1.25 |
| 7 | RPHP-48 | 21.43 | -5.38 | -1.38 | 16.05 | 1.03 | 7.79 * |
| 8 | RPHP51 | 21.44 | 0.47 | -1.09 | 17.16 | 1.08 | 3.68 |
| 9 | RPHP-52 | 24.95 | -1.88 | -1.53 | 19.76 | 1.18 | -0.76 |
| 10 | RPHP-56 | 21.06 | 5.95 | -1.52 | 15.59 | 1.08 | 16.23 ** |
| 11 | RPHP59 | 23.32 | 1.22 | -1.53 | 18.74 | 1.05 | -0.91 |
| 12 | RPHP 80 | 26.87 | 11.41* | -1.57 | 24.19 | 1.21 | 41.87 ** |
| 13 | RPHP 81 | 23.02 | 2.19 | -1.23 | 17.65 | 1.19 | -1.35 |
| 14 | RPHP84 | 22.22 | -0.89 | -1.57 | 17.40 | 1.23* | -1.43 |
| 15 | RPHP87 | 18.77 | 16.48 | 7.83 * | 11.23 | 0.96 | 55.71 ** |
| 16 | RPHP90 | 21.93 | 3.48 | 0.27 | 15.88 | 1.00 | -1.30 |
| 17 | RPHP91 | 27.09 | -7.63 | -1.44 | 26.13 | 1.77 | 33.57 ** |
| 18 | RPHP92 | 28.92 | 2.19 | 0.68 | 28.48 | 1.44 | 16.39 ** |
| 19 | RPHP 103 | 25.39 | -2.96 | -1.55 | 31.69 | 0.61 | -1.05 |
| 20 | RPHP 104 | 28.49 | -4.36 | -1.50 | 31.66 | 1.70 | -0.38 |
| 21 | RPHP 105 | 24.51 | -3.73 | 3.80 | 35.91 | -0.91 | 192.88 ** |
| 22 | RPHP 106 | 26.37 | -2.62 | -1.40 | 27.67 | 0.82 | -0.82 |
| 23 | RPHP 107 | 28.33 | -12.46 | 9.73 ** | 41.45 | 1.39 | 41.39 ** |
| 24 | RPHP 108 | 20.29 | 12.48 | -1.37 | 25.68 | 3.09 | 47.94 ** |
| 25 | RPHP 114 | 18.96 | 0.05 | -0.97 | 15.79 | 1.01 | 6.80 * |
| 26 | RPHP 129 | 27.36 | -0.18 | -0.99 | 27.64 | 1.70 | 45.25 ** |
| 27 | RPHP 130 | 25.98 | 0.52 | -1.58 | 22.41 | 0.94 | -0.87 |
| 28 | RPHP 134 | 26.32 | -1.20 | -1.46 | 26.40 | 0.96 | 3.97 |
| 29 | RPHP 135 | 23.17 | 9.81* | -1.56 | 16.36 | 1.05 | 50.68 ** |
| 30 | RPHP 138 | 22.96 | -6.75 | -1.074 | 18.56 | 1.15 | 5.79 * |
| 31 | RPHP 157 | 26.83 | -5.40 | -1.42 | 26.32 | 0.79 | 10.67** |
| 32 | RPHP 158 | 15.52 | -12.43 | 1.98 | 20.97 | -0.76 | 68.40 ** |
| 33 | RPHP 163 | 23.87 | 16.84 | -1.17 | 20.61 | 0.27 | 113.62 ** |
| 34 | RPHP 165 | 27.82 | 3.64 | -1.28 | 35.46 | 0.93 | 115.69 ** |
| 35 | RPHP 166 | 17.90 | -1.32 | -1.54 | 12.14 | 0.84 | 2.72 |
| 36 | 1702 | 30.24 | 9.93 | 2.17 | 34.41 | -0.16 | 252.48** |
| 37 | 1708 | 27.79 | 8.15 | -0.09 | 39.35 | 0.17 | 236.78 ** |
| | G.M | 24.44 | | | 23.50 | | |
| | C.D | 3.58 | | | 7.04 | | |
| | C.V | 8.51 | | | 2.49 | | |
| | SEM | 1.02 | | | 4.50 | | |

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