

Genotype  $\times$  Environment Interaction and Yield-Stability Analysis of Rice (*Oryza sativa* L.) Grown in Salt Affected Soil.

### ABSTRACT

This study was conducted during *Kharif*, 2019 At the Students Instructional Farm, MES and Agronomy Farm of A.N.D.U.A.T., Kumarganj, Ayodhya, the trials were set up in RBD with three replications. The experimental material comprised of 25 genotypes of rice were evaluated for 11 quantitative traits under three different environmental locations. High significant mean squares were found for all eleven research characteristics in the environment-specific analysis of variance and the pooled analysis of variance for three environments encompassing one crop season. T-3, Kavery Sampoorna, NDRK-11-27, Moti Gold, and NDRK-11-29 under irrigated circumstances were the genotypes demonstrating high mean performance for grain yield per plant and some of its significant components when considering the mean performance of genotypes under various environmental situations. Out of 25 genotypes tested in three conditions, T-3, Kavery Sampoorna, and NDRK-11-27 had the maximum grain yield per plant. In path coefficient analysis highest positive direct effects on grain yield per plant was exerted by L/B ratio (0.281), followed by panicle length (0.167), number of fertile spikelets per plant (0.092) and days to 50% flowering (0.037). On the other hand, negative direct effects on grain yield per plant was exerted by plant height (-0.255), leaf area index (-0.195), spikelet fertility (-0.187), biological yield per plant and harvest index (-0.126) and productive tillers / plant (-0.049). Positive indirect effects on spikelet fertility was recorded via biological yield per plant (0.040) followed by panicle length via biological yield per plant (0.264), productive tiller per plant via biological yield per plant (0.021) and plant height via biological yield per plant (0.011).

Considering the mean performance and stability parameters, three high yielding genotypes T-3, Kavery Sampoorna and NDRK-11-27 merit due consideration for recommending their exploitation as cultivars or varieties for commercial cultivation and/or as donor for hybridization programme for wide range of environments pertaining especially to different environments. In addition to these genotypes, several other genotypes exhibiting high or average mean performance, desirable non-linear response and stable nature for different characters may also be useful for exploitation as parents in hybridization programme as donors for characters for which they showed superiority even if they had average or low grain yield per plant.

**Keywords:** *Oryza sativa* L., Genotype  $\times$  Environment, Salt soils, Stability,

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## INTRODUCTION:

Rice (*Oryza sativa* L.) is an annual self-pollinated short-day plant of family Poaceae (Graminae) with chromosome number  $2n=2x=24$ . Rice is the staple food of more than 2.7 billion people. Over 2 billion people in Asia alone derive 80% of their energy needs from rice (Juliano, 1985). It is the rich source of energy and contains reasonable amount of protein 6-10%, carbohydrate 70-80%, mineral 1.2-2% and vitamins (Riboflavin, thiamine, niacin and vitamin E). Rice is cultivated worldwide over an area of about 153.51 million ~~hectare~~hectares with annual production of 650.19 million tonnes. India ranked first in area having 46.38 million hectares and second in production 130.29 million tones (Agricultural Statistics at a Glance 2022) The production of rice in U.P. is 19.32 million hectares area and production 44.01 million tones (Press Information Bureau, Government of India, 2018).

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Analysis of yield stability and the genotype by environment ( $G \times E$ ) interaction have remained crucial in assessing the stability of a varietal and its appropriateness for cultivation through seasons and ecological zones. Despite the crop's importance, the study of the interactions between genotype and environment in rice agriculture, particularly inland swamp-based farming, has not gotten enough attention. Although McLaren and Chaudhary (1994) published a thorough investigation on  $G \times E$  in rice, the study's global emphasis disguised several intricate genotypic and environmental subtleties unique to the ecologies where the crop is grown. As yield is a polygenically controlled character, the presence or absence of Genotype  $\times$  Environment (GE) interaction largely determines the average response of the varieties.  $G \times E$  interaction, linked with high yield suggests the suitability of variety in varying environments. But this ideal condition is rare and the varieties with high stability generally show low yield capacity and vice versa. Evaluating genotypes under various contrasting environments with uncertain variation is a recognized approach for choosing stable genotypes. A stable variety can be defined as the one having unit regression coefficient ( $b=1$ ) and the least possible departure from the regression line ( $S^2_d=0$ ) (Eberhart and Russel, 1966).

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## MATERIALS AND METHOD:

This study was conducted during *Kharif*, 2019 At the Students Instructional Farm, MES and Agronomy Farm of A.N.D.U.A.T., Kumarganj, Ayodhya. The trials were set up in RBD with three replications. The experimental material for the present investigation was comprised of 25 lines of rice germplasm along with 2 checks *viz.*, CSR-10, NDR-2064. Twenty-five diverse lines were evaluated at three different sodicity levels. Recommended cultural practices were followed to raise a good crop. Five plants from each treatment were selected randomly for recording following observations except days to 50% flowering which were recorded on plot basis. To ensure a successful harvest, all recommended agronomic techniques were implemented in every plot replication. **On five randomly selected plants from each genotype in each replication.** we recorded data on eleven different quantitative characteristics, including plant height (cm),

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productive tillers per plant, ~~penicle~~panicle length, leaf area index (cm<sup>2</sup>), no of fertile spikelet per penicle, spikelet fertility(%), biological yield per plant(g), harvest index(%), L/B ratio and grain yield per plant(g). The average performance value was derived using statistical analysis of the data from each replication. Data ~~was~~ were subjected for analysis of Phenotypic stability analysis (Eberhart and Russell, 1966),

## RESULT AND DISCUSSION:

The interactions of Genotypes ~~x~~ Environment are of major importance to plant breeders in developing novel crop varieties to a target environment. In general, the environment is created due to differences in edaphic and climatic factors. The data collected on 11 plant characters of 25 genotypes over three different environments were subjected to stability analysis. Mean sum of squares due to genotype ~~x~~ environment interactions for all most all the characters viz., days to 50% flowering, no. of effective tiller, plant height, panicle length, number of filled grains per panicle, spikelet fertility percent, grain yield per plant, L/B ratio, leaf area index, biological yield per plant and harvest index were significant. Hence, stability analysis for those characters was carried out according to Eberhart and Russel (1966) model after testing the homogeneity of error variances. These results are similar to those of Mosavi *et al.* (2013) ~~and~~ Palanog *et al.* (2014).

The three stability parameters viz., mean, regression coefficient (bi) and mean square deviation from regression line (S<sup>2</sup>di) were estimated for all the eleven traits and the results obtained are presented trait wise in the Tables 2.

### Days to 50% flowering

\_\_\_\_\_ The genotypes Puas Basmati-1 had recorded highest mean value for days of 50% flowering. It possessed bi>1 and S<sup>2</sup>di=0. It indicated that ~~this genotype~~ this genotype is stable for favorable environmental condition. While, Royal Bhog possessed bi>1 and S<sup>2</sup>di=0. It means this genotype is stable for favorable environments. (Palanog *et al.* (2014), Vivekanandan and Subramanian (1994)

### Plant height (cm)

\_\_\_\_\_ The genotype CSR-1620 had recorded highest mean value for plant height. It possessed bi>1 and S<sup>2</sup>di=0. This genotype is stable for ~~favorable~~ favourable environments conditions. While, genotype KALANAMAK had bi<1. This genotype is stable for ~~unfavorable~~ unfavourable environments. Ramalingam *et al.* (1990).

### Number of productive tillers per plant

The genotypes Kavery Chintoo recorded highest mean value for productive tillers per plant. It possessed bi>1 and S<sup>2</sup>di=0. It showed that this genotype is stable for favorable environmental conditions. However, CSR-10 possessed bi>1 and S<sup>2</sup>di=0. It showed that this genotype is stable for favorable environments condition. (Krishnappa *et al.* (2009)

### Panicle length (cm)

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The genotypes Ideva had recorded highest mean value for panicle length. It possessed  $bi < 1$ . It showed that this genotype is stable for unfavorable environmental conditions. Genotype CSR-20 possessed  $bi > 1$ . It showed that this genotype is stable for favorable environments conditions. (Vivekanandan and Subramanian (1994)).

#### Leaf area index ( $cm^2$ )

The genotypes NDRK-11-30 reported highest mean value for leaf area index. It possessed  $bi < 1$ . It showed that this genotype is stable for unfavorable environments. However, genotype Kavery Sampoorna possessed  $bi < 1$  and  $S^2di = 0$ . It showed that this genotype is stable for unfavorable environmental conditions. (Vivekanandan and Subramanian (1994)).

#### Number of fertile spikelets per panicle

The genotypes Moti Gold reported highest mean value for number of fertile spikelet per panicle. It possessed  $bi < 1$  and  $S^2di = 0$ , it showed that this genotype is stable for unfavorable environmental conditions. Genotype CSR-13 possessed  $bi < 1$  and  $S^2di = 0$ . This genotype showed stable for unfavorable environments conditions. The genotypes Pusa Basmati-1 reported highest mean value for spikelet fertility. It possessed  $bi < 1$  and  $S^2di = 0$ , it showed that this genotype is stable for unfavorable environmental conditions. Genotype NDR-2064 possessed  $bi < 1$  and  $S^2di = 0$ . This genotype showed stable for unfavorable environments conditions. Mosaviet *et al.* (2013).

**Comment [kd3]:** Discuss spikelet fertility (%) parameter

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#### Biological yield per plant (g)

The genotypes NDR-2064 reported highest mean value for biological yield per plant. It possessed  $bi < 1$  and  $S^2di = 0$ . it showed that this genotype is stable for unfavorable environmental conditions. Susk Samrat possessed  $bi < 1$ . This genotype showed stable for unfavorable environments conditions. (Ramalingam *et al.* (1990) and Chaudhuri *et al.* (1999)).

#### Harvest index (%)

The genotypes Kala Namak reported highest mean value for harvest index. It possessed  $bi < 1$ . It showed that this genotype is stable for unfavorable environmental conditions. While, T-3 possessed  $bi < 1$  and  $S^2di = 0$ . This genotype showed stable for unfavorable environments conditions. (Ramalingam *et al.* (1990)).

#### L/B ratio (%)

The highest L/B ratio was registered in genotypes NDR 2064 (3.95) whereas the lowest L/B ratio was found in CSR-13 (1.76). Seventeen genotypes exceeded and seven genotypes were at par to the general mean (3.00). The genotypes NDR- 2064 reported highest mean value for L/B ratio. It possessed  $bi > 1$  and  $S^2di = 0$ . It showed that this genotype is stable for favorable environmental conditions. While, CSR-13 possessed  $bi > 1$  and  $S^2di = 0$ . This genotype showed stable for favorable environments conditions.

### Grain yield per plant (g)

The T-3 recorded the highest grain yield (29.09g) whereas NDRK-11-30 registered the lowest grain yield per plant (10.01 g). Twelve genotypes showed above the general mean (16.27g). The genotypes T-3 reported highest mean value for grain yield per plant. It possessed  $b_i > 1$  and  $S^2d_i = 0$ . It showed that this genotype is stable for favorable environmental conditions. While, NDRK-11-30 possessed  $b_i > 1$  and  $S^2d_i = 0$ . This genotype showed stable for favorable environmental conditions. (Chaudhuri *et al.* (1999) and Krishnappa *et al.* (2009))

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### Conclusion:

Considering the mean performance and stability parameters, the genotypes, Pusa Basmati-1, emerged as the most desirable genotype among the 25 genotypes. T-3 produced highest grain yield per plant (29.09g) across three environments. NDRK-11-30 showed average responsiveness ( $b_i < 1$ ) for grain yield per plant with stable for unfavorable environments ( $S^2d_i = 0$ ) for grain yield per plant. Moti Gold was present in the top non-significant group for higher grain yield per plant alone thereby significantly out yielding the remaining 24 genotypes. The genotypes T-3 (29.09g), and Kaveri Sampoorna (24.84g) produced higher grain yield per plant. These genotypes had  $b_i > 1$  and  $S^2d_i = 0$  showed non-linear and stable ( $S^2d_i = 0$ ) for favorable environment.

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UNDER PEER REVIEW

Table- 1: The pooled analysis of variance for 11 characters of 25 rice genotypes across three environments

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| Source of variation       | d. f. | Days to 50% flowering | Plant height (cm) | Productive tillers/plant | Panicle length (cm) | Leaf Area Index (cm) | Number of fertile spikelet /panicles | Spikelet fertility (%) | Biological yield/plant (g) | Harvest Index (%) | L/B ratio (%) | Grain yield/plant (g) |
|---------------------------|-------|-----------------------|-------------------|--------------------------|---------------------|----------------------|--------------------------------------|------------------------|----------------------------|-------------------|---------------|-----------------------|
| Replication               | 2     | 1429.48               | 48.520            | 34.4332                  | 248.970             | 111.59               | 15379.5                              | 514.488                | 4882.35                    | 544.458           | 2.91988       | 77.907                |
| Genotype                  | 26    | 184.49**              | 723.908**         | 10.3499**                | 54.882*<br>*        | 54.85*<br>*          | 808.1**                              | 109.669**              | 237.27**                   | 96.169*<br>*      | 1.56616*<br>* | 57.476**              |
| Replication × Environment | 4     | 35.23**               | 382.228**         | 1.5425**                 | 11.011*<br>*        | 116.50*<br>*         | 700.1**                              | 94.297*<br>*           | 363.68**                   | 18.322*<br>*      | 1.15263*<br>* | 110.754**             |
| Genotype × Environment    | 46    | 19.78*                | 75.10**           | 4.377**                  | 11.21**             | 1339*<br>*           | 22.33**                              | 7.68**                 | 15.94**                    | 5.23**            | 0.12**        | 12.21**               |
| Error                     | 138   | 14.81                 | 95.23             | 5.61                     | 16.35               | 1678                 | 44.34                                | 8.29                   | 18.88                      | 6.22              | 0.17          | 6.20                  |

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\*, \*\* Significant at 5% and 1% probability levels, respectively.

**Table 2: Stability analyses of 11 characters of rice genotype**

| Genotype         | Days to 50% flowering |        |                   | Plant height(cm) |         |                   | Panicle length(cm) |         |                   | Leaf Area Index (cm <sup>2</sup> ) |         |                   | Productive tiller per plant |         |                   |
|------------------|-----------------------|--------|-------------------|------------------|---------|-------------------|--------------------|---------|-------------------|------------------------------------|---------|-------------------|-----------------------------|---------|-------------------|
|                  | Mean                  | bi     | S <sup>2</sup> di | Mean             | bi      | S <sup>2</sup> di | Mean               | bi      | S <sup>2</sup> di | Mean                               | bi      | S <sup>2</sup> di | Mean                        | bi      | S <sup>2</sup> di |
| CSR-10           | 96.1489               | 0.8864 | 54.3925           | 105.8311         | -1.5581 | -141.384          | 24.7144            | 0.6522  | -4.1837           | 28.5711                            | 1.7131  | -6.5032           | 10.9656                     | 2.1397  | -1.7365           |
| CSR-13           | 93.0967               | 2.3946 | -9.1081           | 107.0311         | 3.375   | 141.9836          | 24.72              | 1.361   | 11.5534           | 27.0322                            | 4.1704  | -7.3118           | 11.2811                     | -1.7086 | -0.8406           |
| CSR-1620         | 91.8289               | 1.074  | 6.3328            | 109.7078         | 1.8552  | -188.309          | 25.6289            | 2.9928  | 17.947            | 26.3756                            | 2.4133  | -11.8447          | 11.0633                     | -1.1613 | 4.2406            |
| CSR-20           | 94.8667               | 0.3236 | 27.1779           | 112.9422         | 5.8651  | 494.118           | 26.4144            | 2.1668  | 16.283            | 24.9844                            | 2.8484  | -4.3935           | 10.1556                     | 1.219   | -0.1871           |
| CSR-27           | 93.6189               | 1.5441 | -3.5397           | 104.1378         | 3.4747  | -132.213          | 25.56              | 0.6217  | -1.9337           | 26.1756                            | 1.6956  | -11.9916          | 11.1222                     | 1.9606  | -1.882            |
| Damini Delta     | 93.0578               | 1.5285 | 4.8715            | 112.9022         | 0.1958  | -188.842          | 24.1911            | 0.6192  | -3.485            | 24.2257                            | 0.4229  | 2.8295            | 9.4533                      | 1.3842  | -1.5644           |
| Ideva            | 96.4522               | 0.2854 | 2.8655            | 103.3589         | -2.7539 | -189.194          | 23.9578            | 0.9774  | 28.972            | 25.8411                            | 2.2484  | 9.8831            | 11.1989                     | 2.3482  | 0.2965            |
| Kala Namak       | 93.0433               | 2.2575 | -12.7022          | 103.0911         | -1.6664 | 249.7204          | 25.3289            | 0.9742  | 2.8316            | 24.6111                            | 0.6543  | -12.3927          | 10.47                       | -0.445  | -1.9433           |
| Kasturi          | 94.5411               | 0.9683 | -13.3472          | 102.8622         | -2.3579 | -7.3069           | 25.4522            | 0.7292  | -3.0981           | 25.2867                            | 1.7637  | -12.3763          | 11.6656                     | 2.7669  | 2.6282            |
| Kavery Chintoo   | 94.7811               | 0.267  | -13.9681          | 93.3644          | 3.5501  | -180.739          | 25.0278            | 1.3123  | 10.8636           | 24.82                              | 1.0696  | 0.7442            | 10.0111                     | 2.0601  | -1.2395           |
| Kavery Sampoorna | 96.1589               | 0.5612 | -9.3223           | 111.7144         | -1.0287 | 158.0984          | 24.0189            | 2.2002  | -4.9542           | 22.9222                            | -1.001  | -11.8032          | 9.1656                      | 1.5308  | -1.9447           |
| KR15100          | 97.7889               | 0.3105 | -6.4314           | 104.9089         | 0.8476  | -51.2659          | 23.5367            | 0.2497  | 11.6841           | 26.6956                            | 4.5514  | -11.5426          | 9.6422                      | 2.1891  | -1.9369           |
| Moti Gold        | 95.1544               | 1.4773 | 4.0176            | 115.3989         | 0.9821  | 9.648             | 22.4256            | -0.5322 | 0.8574            | 23.6244                            | 0.8514  | -12.1515          | 8.8922                      | 3.006   | -1.6255           |
| NDR-2026(Richa)  | 90.2822               | 0.852  | -12.0171          | 110.4122         | 1.9045  | -65.9479          | 24.44              | -0.7027 | -2.667            | 26.5211                            | 1.1575  | -12.3966          | 10.6933                     | 0.9076  | 0.9788            |
| NDR-2064         | 92.5278               | 0.699  | -12.503           | 108.6522         | 4.5045  | 14.0167           | 25.8633            | 0.91    | -2.9716           | 29.3989                            | 1.8962  | -10.0402          | 10.5889                     | -1.2633 | -1.1725           |
| NDRK-11-29       | 97.5744               | 0.7608 | 3.17              | 103.0989         | 1.2866  | -187.869          | 26.05              | 2.3348  | 3.6654            | 23.6889                            | -0.2844 | 3.6793            | 11.1644                     | -0.9025 | 3.7834            |
| NDRK-11-30       | 94.2222               | 1.2015 | -10.0108          | 104.8022         | 3.931   | -68.2183          | 25.0644            | 1.5542  | 1.0169            | 25.4089                            | -0.9083 | 8.0825            | 10.7178                     | 0.4487  | -1.8602           |
| NDRK-1127        | 97.8444               | 1.0962 | -12.6873          | 111.26           | 3.5787  | 151.5448          | 24.4889            | 0.4033  | -2.9094           | 23.8656                            | -0.1372 | -11.6076          | 9.9133                      | -1.8284 | -0.8584           |
| NDRK-133         | 94.3822               | 1.1343 | 17.9474           | 106.5078         | -0.6398 | -169.525          | 24.5556            | -0.7174 | -4.0279           | 24.7656                            | -0.7025 | 18.0518           | 10.0456                     | 1.5505  | -1.207            |
| PantDhan-10      | 92.3289               | 0.5187 | -13.7535          | 104.1822         | -1.9229 | -160.279          | 26.7644            | 2.5557  | -4.9698           | 23.5433                            | 1.3736  | -10.8171          | 9.6                         | -0.3259 | -1.9164           |
| Pusa Basmati-1   | 92.3456               | 1.6177 | -6.5594           | 108.0422         | 4.5919  | 974.3598          | 25.54              | 1.293   | -2.6763           | 24.7                               | 0.8546  | -9.8619           | 11.1                        | -1.9431 | -1.7174           |
| Pusasugandha-5   | 93.6978               | 1.5996 | 45.9442           | 104.5689         | 0.2331  | 111.5858          | 25.6144            | 1.136   | -3.1843           | 25.8067                            | 3.3103  | -9.2153           | 9.3089                      | 0.7367  | -0.9964           |
| Raghuvansi-4     | 95.9544               | 0.3228 | 61.6726           | 104.8233         | -1.9202 | 826.216           | 25.2022            | 1.4894  | -1.124            | 20.8256                            | -1.7287 | -7.6689           | 10.2822                     | 3.1297  | 2.7076            |
| Royal Bhog       | 96.39                 | 1.1246 | -6.5442           | 114.0722         | 1.8648  | -91.0509          | 24.0322            | -0.2442 | 8.1447            | 26.1022                            | -2.2094 | 10.5584           | 10.8567                     | 2.4104  | -1.7244           |
| Susksamrat       | 96.5289               | 1.0107 | -0.3762           | 102.7656         | 4.0536  | 1438.165          | 24.5911            | 2.098   | 0.4168            | 21.9867                            | -0.4603 | 2.1987            | 10.6178                     | 1.7509  | -1.8762           |
| T-3              | 96.2433               | 0.3619 | 10.8158           | 99.4278          | -2.3808 | 452.5384          | 25.5211            | 0.0444  | -4.7661           | 20.9811                            | -0.7633 | 27.0873           | 9.4211                      | 2.0363  | -1.7966           |
| Vandana          | 95.26                 | 0.8218 | -3.3655           | 103.2922         | -2.8656 | -184.197          | 26.1667            | 0.5209  | -4.8482           | 28.3833                            | 2.2005  | -10.1474          | 9.9589                      | 3.0028  | -0.2438           |

| Genotype         | No of fertile spikelet per panicle |         |                   | Spikelet fertility (%) |         |                   | L/B ratio (%) |         |                   | Harvest index (%) |         |                   |
|------------------|------------------------------------|---------|-------------------|------------------------|---------|-------------------|---------------|---------|-------------------|-------------------|---------|-------------------|
|                  | Mean                               | bi      | S <sup>2</sup> di | Mean                   | bi      | S <sup>2</sup> di | Mean          | bi      | S <sup>2</sup> di | Mean              | bi      | S <sup>2</sup> di |
| CSR-10           | 130.9722                           | 0.025   | -107824           | 80.6833                | 1.8849  | -18.1437          | 2.6267        | -0.114  | -0.0629           | 41.5944           | -0.2531 | -18.836           |
| CSR-13           | 119.1433                           | -0.2587 | -106798           | 80.8278                | -1.8717 | 6.6209            | 2.4578        | 1.8164  | -0.0785           | 28.5444           | 0.4768  | -35.0124          |
| CSR-1620         | 104.21                             | 0.0528  | -107912           | 78.0378                | 1.806   | 0.9196            | 2.9056        | 2.1518  | -0.0504           | 33.2956           | 0.1451  | 62.2698           |
| CSR-20           | 1089.083                           | 26.7844 | -81213.8          | 79.3744                | 1.0199  | 7.6027            | 2.4878        | 0.2736  | -0.1019           | 36.2789           | 1.4367  | 175.0629          |
| CSR-27           | 121.4622                           | -0.1433 | -107882           | 74.5867                | 1.2383  | -30.4167          | 2.6367        | 1.6982  | -0.0177           | 35.8833           | 0.618   | -35.3243          |
| Damini Delta     | 120.5522                           | 0.1935  | -107128           | 82.0889                | 0.2002  | -33.5696          | 2.6244        | -0.8707 | -0.0316           | 38.8989           | 0.3984  | -11.0421          |
| Ideva            | 113.4033                           | 0.2285  | -107825           | 73.9944                | 5.3908  | -1.4751           | 2.7344        | -0.4019 | -0.0837           | 40.7878           | 3.1651  | -35.704           |
| Kala Namak       | 116.3656                           | 0.0181  | -107606           | 84.4733                | 1.3162  | -33.127           | 2.8122        | -0.5471 | -0.0876           | 32.5689           | -0.7726 | 15.4794           |
| Kasturi          | 131.5556                           | 0.1782  | -107670           | 82.7274                | 0.5388  | -10.8604          | 2.6878        | 2.1361  | -0.1033           | 33.9089           | -1.8746 | -38.4133          |
| Kavery Chintoo   | 119.6856                           | -0.0849 | -107464           | 81.3478                | -0.2969 | -31.1247          | 2.8856        | 1.6265  | -0.0615           | 33.8289           | 4.1474  | 1.9371            |
| Kavery Sampoorna | 109.5133                           | 0.4577  | -107741           | 76.3322                | 2.664   | -33.0348          | 2.8311        | 2.0417  | -0.0621           | 30.0133           | 1.5625  | -23.0983          |
| KR15100          | 119.78                             | -0.0699 | -107713           | 71.9767                | -0.1575 | -8.6524           | 2.9122        | 0.8669  | 0.0125            | 34.48             | 0.9093  | 347.1764          |
| Moti Gold        | 122.0233                           | 0.0153  | -107916           | 80.3878                | 2.102   | -25.5893          | 2.8167        | 1.6928  | -0.0862           | 35.4022           | 1.1409  | -32.1861          |
| NDR-2026(Richa)  | 126.2033                           | -0.0822 | -107917           | 81.2233                | 1.1889  | -29.3365          | 2.69          | 0.9237  | -0.0897           | 37.1989           | 1.6907  | 36.4813           |
| NDR-2064         | 124.4656                           | 0.0903  | -107649           | 82.3889                | -1.4506 | -20.5651          | 2.6144        | 1.0366  | -0.0655           | 33.9711           | 1.6164  | 1.9931            |
| NDRK-11-29       | 118.2256                           | -0.2829 | -107606           | 82.2344                | 1.8736  | -33.9476          | 2.8389        | 0.6869  | -0.1035           | 36.9656           | -0.1838 | -36.4208          |
| NDRK-11-30       | 106.3789                           | -0.1593 | -107892           | 82.4322                | -0.3922 | -27.6319          | 2.6089        | 0.3511  | -0.1019           | 32.4533           | 1.7878  | 30.9379           |
| NDRK-1127        | 115.0089                           | -0.2491 | -107494           | 82.1556                | 1.3943  | 37.2757           | 2.7311        | 2.5132  | -0.0917           | 38.83             | 1.2125  | -30.5953          |
| NDRK-133         | 115.59                             | -0.1572 | -107911           | 79.6656                | 1.5542  | -32.888           | 2.7889        | 0.5981  | -0.1047           | 39.9056           | 3.0564  | -30.538           |
| PantDhan-10      | 110.7533                           | 0.0775  | -107665           | 81.4189                | -0.6812 | -12.2214          | 2.6956        | -0.3154 | -0.1053           | 33.1644           | 1.3102  | -33.0319          |
| Pusa Basmati -1  | 116.9678                           | -0.1262 | -107811           | 83.8978                | -0.4669 | -29.1786          | 2.7044        | -1.398  | 0.0572            | 28.54             | 0.0857  | 18.9286           |
| Pusasugandha-5   | 120.9956                           | 0.198   | -107687           | 70.1533                | 6.5576  | -32.5902          | 2.8289        | 0.1905  | -0.0985           | 33.1256           | 0.7948  | 97.4765           |
| Raghuvansi-4     | 106.4489                           | 0.2366  | -107906           | 81.24                  | 0.415   | 8.6247            | 2.7656        | 3.7792  | -0.1053           | 33.6233           | 0.52    | -39.1558          |
| Royal Bhoga      | 117.6533                           | -0.1112 | -106471           | 83.9844                | -1.0026 | -15.1438          | 2.8867        | 1.9078  | 0.2741            | 37.1056           | 1.6062  | -38.3822          |
| Susksamrat       | 107.1244                           | 0.3542  | -107888           | 84.2722                | 1.353   | -32.4697          | 2.3367        | 1.2116  | -0.0621           | 37.2511           | 1.9611  | -5.4373           |
| T-3              | 121.17                             | -0.0922 | -106694           | 82.6911                | 0.1912  | -30.9198          | 2.6744        | 4.2859  | 0.0877            | 33.6444           | 0.5452  | -39.1415          |
| Vandana          | 133.2211                           | -0.0929 | -107884           | 77.8166                | 0.631   | -27.7769          | 3.0433        | -1.1416 | -0.1038           | 36.2244           | -0.1033 | 84.7498           |

| Genotype        | Biological yield per plant (g) |         |                   | Grain yield per plant (g) |         |                   |
|-----------------|--------------------------------|---------|-------------------|---------------------------|---------|-------------------|
|                 | Mean                           | Bi      | S <sup>2</sup> di | Mean                      | bi      | S <sup>2</sup> di |
| CSR-10          | 45.69                          | -0.4685 | -48.8701          | 18.3667                   | -0.6131 | -6.0296           |
| CSR-13          | 49.0567                        | 0.3779  | 33.7243           | 13.6878                   | 0.3793  | 1.4538            |
| CSR-1620        | 45.55                          | 1.04    | -48.8339          | 15.1101                   | 0.3607  | 20.6599           |
| CSR-20          | 47.5211                        | 0.7258  | -47.8649          | 16.5544                   | 1.6927  | 26.4663           |
| CSR-27          | 45.5256                        | -0.016  | 17.8061           | 15.4311                   | -0.0049 | 3.2257            |
| Damini Delta    | 47.6467                        | -1.3006 | -44.9021          | 18.0067                   | -0.5515 | 1.5971            |
| Ideva           | 44.8311                        | 0.5713  | 37.6671           | 17.0789                   | 1.9247  | -2.9241           |
| Kala Namak      | 40.3322                        | 3.2688  | -30.5768          | 12.3411                   | 0.8119  | -3.8926           |
| Kasturi         | 47.3689                        | 2.9546  | -30.465           | 15.8611                   | 0.1479  | -2.8447           |
| Kavery Chintoo  | 48.1489                        | 0.6725  | -45.0207          | 15.0333                   | 2.5629  | -5.8382           |
| Kavery Sampurna | 48.0822                        | 2.5352  | -32.5796          | 14.1633                   | 1.756   | -4.5126           |
| KR15100         | 45.0389                        | -0.0852 | 18.5527           | 14.9078                   | 0.5728  | 24.5024           |
| Moti Gold       | 47.57                          | 1.1778  | 1.3683            | 16.6378                   | 1.3378  | 15.2699           |
| NDR-2026(Richa) | 50.2278                        | -0.0552 | -45.1778          | 17.4889                   | 0.7956  | -1.1018           |
| NDR-2064        | 49.62                          | -1.5818 | -48.5165          | 16.5344                   | 0.6052  | 3.1239            |
| NDRK-11-29      | 43.6211                        | 2.4596  | -5.146            | 15.5244                   | 0.9196  | -3.8419           |
| NDRK-11-30      | 49.1356                        | -0.3919 | -48.8027          | 15.63                     | 1.1323  | 13.6494           |
| NDRK-1127       | 44.6356                        | 1.8638  | -28.8295          | 17.2211                   | 1.5977  | -6.0511           |
| NDRK-133        | 39.79                          | -1.4397 | -48.8613          | 15.2922                   | 1.0197  | -5.8529           |
| PantDhan-10     | 47.0344                        | 3.2605  | -48.0043          | 15.2933                   | 2.2316  | -2.4911           |
| Pusa Basmati-1  | 46.6422                        | 2.7128  | -48.7355          | 12.4                      | 1.138   | 8.9568            |
| Pusasugandha-5  | 45.6833                        | 2.3045  | 104.5142          | 14.6111                   | 1.2868  | -4.9975           |
| Raghuvansi-4    | 41.9589                        | 1.4542  | -43.9991          | 13.7533                   | 1.0163  | -5.5789           |
| Royal Bhog      | 46.4667                        | 2.027   | 39.4448           | 17.4222                   | 2.0069  | 8.4813            |
| Susksamrat      | 47.1178                        | -0.2309 | 100.4813          | 17.0667                   | 1.1372  | -1.9478           |
| T-3             | 49.16                          | 2.7341  | -9.0611           | 16.62                     | 1.6103  | -0.3199           |
| Vandana         | 48.8933                        | 0.4293  | -41.0803          | 17.7489                   | 0.1252  | 11.8609           |

## References:

Agricultural Statistics at a Glance 2022

- Chaudhuri, R. K., Panda, P. K., Das, B. P., Mahapatra, U. S., & Mukherjee, D. (1999). Relativistic coupled-cluster-based linear response theory for ionization potentials of alkali-metal and alkaline-earth-metal atoms. *Physical Review A*, 60(1), 246
- Eberhart, S.A. and Russel, W.A. (1966). Stability Parameters for Comparing Varieties. *Crop Science*. 6(1): 36-40.
- Juliano, B.O. (1985). Criteria and Tests for Rice Grain Qualities. In: *Rice Chemistry and Technology*, 2nd Edition, American Association of Cereal Chemists, 443-524.
- Krishnappa, M. R., Chandrappa, H. M., & Shadakshari, H. G. (2009). Stability analysis of medium duration hill zone rice genotypes of Karnataka. *Crop Research (Hisar)*, 38(1/3), 141-143.
- McLaren CG, Chaudhary C (1994). Use of additive main effects and multiplicative interaction models to analyse multilocation rice variety trials. Paper presented at the FCSSP Conference, Puerton Princesa, Palawan, Philippines
- Mosavi, S. A., & Kenarehfar, M. (2013). The impact of value creation practices on brand trust and loyalty in a Samsung galaxy online brand community in Iran. *International Journal of Mobile Marketing*, 8(2), 75-84.
- Palanog, A. D., Swamy, B. M., Shamsudin, N. A. A., Dixit, S., Hernandez, J. E., Boromeo, T. H., ... & Kumar, A. (2014). Grain yield QTLs with consistent-effect under reproductive-stage drought stress in rice. *Field Crops Research*, 161, 46-54.
- Ramalingam, A., Muralidhar, V., & Sheriff, N. M. (1990). Combining ability studies in sesame. *Journal of Oilseeds Research*, 7(2), 75-77.
- Ramalingam, J., Vivekanandan, P., Vanniarajan, C., & Subramanian, M. (1994). Heterosis in early rice. *Ann. Agric. Res*, 15(2), 194-198.

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