Journal of Cereal Research
14(1): 63-75
Homepage: http://epubs.icar.org.in/ejournal/index.php/JWR
Research Article

# Morphological characterization of red rice germplasm of Himachal Pradesh and identification of potential genotype for yield and biotic stress tolerance

Praveenkumar Alagappan[1*] and Neelam Bhardwaj[2]

[1]*Department of Genetics and Plant Breeding, CSK Himachal Pradesh Agricultural University, Palampur, India*
[2]*CSK Himachal Pradesh Agricultural University, Rice and Wheat Research Centre, Malan (176 047), India*

***Article history:***
Received: 17, Dec., 2021
Revised: 11, Mar., 2022
Accepted: 29, Mar., 2022

***Citation:***
Praveenkumar A and Neelam Bhardwaj N. 2022. Morphological characterization of red rice germplasm of Himachal Pradesh and identification of potential genotype for yield and biotic stress tolerance. *Journal of Cereal Research* ***14(1):*** *63-75. http://doi.org/10.25174/2582-2675/2022/114778*

****Corresponding author:***
*E-mail: praveenkumaralagappan@gmail.com; praveenkumaralagappan@gmail.com*



## Abstract

**The present investigation was carried out in Rice &Wheat Research Centre Malan of with thirty-five red rice germplasm lines collected across Himachal Pradesh Observations were recorded on twelve quantitative six grain quality traits. Analysis of variance showed presence of variability for all traits except flag leaf length, harvest index and grain breadth among the germplasm lines. Analysis of parameter of variability exhibited high heritability coupled with high genetic advance as percent of mean for biological yield per plant, thousand grain weight and L:B ratio which indicated the presence of high additive gene action and selection for such traits may be beneficial in future breeding programme. The mean performance of genotypes was compared with best check with particular trait and genotypes- Deval, HPR-2913, HPR-2908 were found to be promising for most of the traits including grain quality. The disease reaction for leaf and neck blast among genotypes indicated that, IC-12180, HPR-2800, HPR-2795, HPR-2913 and HPR-2914 were found to be resistance to both blast disease.**

**Keywords:** Heritability, genetic advance, mean performance, disease reaction

## 1. Introduction

Rice (*Oryza sativa L.*) is the most popular and important cereal crops in the world. In Asia, over two billion people derive 80% of their daily energy needs through rice, which contains around 80% carbohydrates, 7-8% crude proteins, 3% crude fat and 3% crude fiber (Raghuvanshi et al., 2017). The total volume of milled rice production in worldwide estimated at 507.4 million metric tons in the 2020/2021. Among all the rice growing countries, India is reported to be at second place with 121 million metric tons of milled rice (Anonymous, 2021).

Rice has immense genetic diversity by having thousands of varieties grown around world under vast climatic condition. In India alone, currently over six thousand varieties are under cultivation. Originally, India has more than 1,10,000 varieties of rice until late 1970s but, most of these varieties became extinct after the advent of green revolution which promoted hybrid crops and monoculture (Anonymous, 2012). The trend toward hybrids from traditional varieties may be reversing in past few years as traditional varieties are experiencing an increasing trend among consumers, due to their incredible health benefits. Among traditional varieties, nutritional properties of pigmented red rice and black rice have been verified in numerous nutritional cases. In India, red rice is prevalent in south, east and hilly tracts of Himalayas. Among these, Himalayan red rice has made its presence felt in the export market for its long and slender characters and also called as RED PEARLS of Himalayas (Kaushik

et al., 2014). For the conservation and utilization of this precious germplasm, it is important to well characterize the germplasm for morphological traits that can be used as basic information for rice breeding programme and these observations are taxonomy-based observation, to find out the plant properties. Hence in the present study an effort has been made to characterize red rice germplasm collected across Himachal Pradesh.

## 2. Material and method

### *2.1 Material Used:*

The present investigation consisted of thirty-five diverse red rice germplasm lines collected locally around Himachal Pradesh and three checks. Out of the three checks, two checks *viz.,* HPR-2720, HPR-2795 were Indica type and one *viz.,* Varun Dhan was Japonica type. These genotypes were evaluated in Randomised Complete Block Design with three replications. All the genotypes were raised in experimental farm of Rice and Wheat Research Centre, Malan in *Kharif, 2020.* Each entry was raised in a plot of 2.4m$^2$ with row-to-row and plant to plant distance of 20cm and 15cm, respectively.

### *2.2 Observations recorded:*

The morphological traits studied in present investigation included, twelve quantitative characters along with six grain quality traits. The quantitative traits were, days to 50% flowering, days to 75% maturity, plant height, flag leaf length, flag leaf width, total tillers per plant, effective tillers per plant, spikelets per panicle, thousand grain weight, harvest index and grain yield per plant, whereas grain quality traits included seed coat colour, grain length, grain breadth, grain L:B ratio, lodging effect and presence or absence of awns. In the present study all the genotypes were also observed for reaction to leaf and neck blast under open field conditions on the basis of Standard Evaluation System (IRRI., 2013).

### *2.3 Statistical analysis:*

Analysis of variance (ANOVA) was carried out using Panse and Sukhatme (1989). The genotypic, phenotypic and environmental coefficient of variation were estimated according to Burton and De vane (1953) and the estimation of heritability and genetic advance was computed in accordance with the method suggested by Burton and De-Vane (1953) and Johnson et al., (1955).

## 3. Result and Discussion

### *3.1 Analysis of Variance*

Analysis of variance showed presence of significant differences among genotypes for all the traits studied, except for flag leaf length, harvest index and grain breadth. This indicated presence of variability for days to 50% flowering, days to 75% maturity, plant height, flag leaf width, total tillers per plant, effective tillers per plant, spikelets per panicle, thousand grain weight, biological yield per plant, grain yield per plant, grain length and grain L:B ratio.

Table 3.1 (a) Analysis of variance of red rice genotypes for yield and related traits

| Source of variation | Mean sum of square | | |
|---|---|---|---|
| | Replication | Treatment | Error |
| **Df** | **2** | **34** | **68** |
| **1. Quantitative traits** | | | |
| Days to 50 % flowering | 19.23 | 144.94** | 6.032 |
| Days to 75 % maturity | 32.77 | 111.34** | 11.762 |
| Plant height (cm) | 189.17 | 809.36** | 64.066 |
| Flag leaf length (cm) | 375.41 | 256.93** | 46.064 |
| Flag leaf width (cm) | 0.06 | 0.28 | 0.038 |
| Total tillers per plant | 4.54 | 13.61** | 1.049 |
| Effective tillers per plant | 4.36 | 11.13** | 0.984 |
| Spikelets per panicle | 214.75 | 630.77** | 51.040 |
| Thousand grain weight(g) | 6.39 | 56.28** | 1.070 |

| | | | |
|---|---|---|---|
| Harvest index (%) | 54.64 | 128.08 | 42.267 |
| Grain yield per plant (g) | 13.70 | 33.02** | 5.096 |
| **2. Grain quality traits** | | | |
| Grain length [L] (mm) | 0.08 | 0.68* | 0.044 |
| Grain Breadth [B] (mm) | 0.004 | 0.07 | 0.005 |
| L:B ratio | 0.02 | 0.30* | 0.009 |

*Significance at 5% **Significance at 1%

### *3.2 Estimation of parameters of variability*

Analysis of parameter of variability showed higher Phenotypic Coefficient of Variation (PCV) in comparison toGenotypic Coefficient of Variation (GCV) for all the traits (Table 3.2(a) and Table3.2(b)) which established that, some degree of environmental factors influenced the expression of traits among genotypes. High PCV and GCV (>20%) was observed in traits viz; effective tillers per plant, total tillers per plant, grain yield per plant and spikelets per panicle. Moderate PCV (10%-20%) were reported for thousand grain weight, harvest index, plant height and grain L:B ratio, while, low PCV (<10%) was reported for days to 50% flowering, days to 75% maturity, grain length and grain breadth. However, high PCV but moderate GCV was observed for flag leaf length and flag leaf width only.

The heritability values were very high (>80%) for days to 50% flowering, thousand grain weight, grain length, grain breadth, grain L:B ratio, while high heritability (61%-80%) values were reported for days to 75% maturity, plant height, flag leaf width, total tillers per plant, effective tillers per plant, spikelets per panicle and grain yield per panicle. Moderate heritability was reported (41% to 60%) for flag leaf length and low heritability (<41%) was observed for harvest index. The high heritability coupled with high genetic advance as percent of mean was reportedfor thousand grain weight and L:B ratio. High heritability with moderate genetic advance as percent of mean was reportedfor days to 50% flowering, grain length and grain breadth as reported in table 3.2(a) and table 3.2(b).

Similar report on days to 50% flowering was also reported by kumar et al. (2020). While report on thousand grain weight and biological yield per plant was found to be similar as observed by Bagudam et al. (2018) as well as by Kumaresan and Manonmani (2019). While, result of Kujur et al. (2019) on biological yield per plant and grain L:B ratio was found to be in accordance with the present study.

Table 3.2 (a) Estimation of parameter of variability for yield and yield contributing traits in red rice genotypes

| Traits | Mean ±SE | Range | PCV % | GCV % | h ²bs (%) | GA as % mean |
|---|---|---|---|---|---|---|
| Days to 50% flowering | 83.37± 1.42 | 71.67-94.00 | 8.68 | 8.16 | 88.47 | 15.81 |
| Days to 75% maturity | 111.83±1.98 | 101.67-124.33 | 6.00 | 5.15 | 73.84 | 9.12 |
| Plant height | 137.95±4.62 | 98.07-166.50 | 12.82 | 11.43 | 79.50 | 20.99 |
| Flag leaf length | 43.69±3.92 | 26.53- 64.43 | 24.69 | 19.19 | 60.41 | 30.72 |
| Flag leaf width | 1.66±0.11 | 1.27-2.27 | 20.58 | 16.92 | 67.65 | 28.67 |
| Total tillers/ plant | 7.55±0.59 | 3.67-12.27 | 30.31 | 27.10 | 79.97 | 49.92 |
| Effective tillers/ plant | 6.80±0.57 | 3.60-12.20 | 30.71 | 27.03 | 77.46 | 49.01 |
| Spikelet/panicle | 59.54±4.13 | 34.60-89.33 | 26.25 | 23.35 | 79.11 | 42.78 |
| 1000 grain weight | 23.90±0.60 | 16.56-35.23 | 18.47 | 17.95 | 94.51 | 35.95 |
| Harvest index | 52.04±3.75 | 33.61-65.54 | 16.18 | 10.28 | 40.36 | 13.45 |
| Grain yield/ plant | 12.61±1.30 | 8.47-21.73 | 30.09 | 24.19 | 64.62 | 40.05 |

Table 3.2(b) Estimation of parameters of variability for the grain quality traits in red rice genotypes

| Traits | Mean ±SE | Range | PCV % | GCV% | h ²bs (%) | GA as % mean |
|---|---|---|---|---|---|---|
| Grain length | 5.99±0.12 | 5.31-7.21 | 8.45 | 7.69 | 82.87 | 14.43 |
| Grain breadth | 2.00±0.04 | 1.75-2.30 | 8.11 | 7.31 | 81.14 | 13.56 |
| L:B ratio | 3.01±0.06 | 2.48-3.64 | 10.76 | 10.28 | 91.34 | 20.24 |

### *3.3 Mean performance of genotypes for yield and related traits*

The mean performance of different genotypes for various traits were reported in table 3.3 (a) and the result established that

#### *3.3.1 Quantitative characters*

#### *a) Days to 50% flowering*

The estimate of mean values indicated that the days to 50% flowering ranged from **71.67- 94 days** with a mean value of **83.37 days**. The genotypes Roda Dhan and Deval were the earliest flowering genotypes while, HPR-2905 was the most late flowering among all the genotypes.

Out of thirty-two genotypes, none of the genotype was found to be significantly superior in comparison to the best check Varun Dhan (73.33 days). However, nine genotypes Roda Dhan, Deval, Doda Dhan, Kalijhini-2, Bathi Dhan, Nailina, IC-12164, HPR-2906 and Kalijhini were considered to be statistically at par with Varun Dhan.

#### *b) Days to 75% maturity*

Days to 75% maturity varied from**101.67 to 124 days** with mean duration of **111.83 days.** Genotype Deval was the most early maturing genotypes. However, Sukara red was found to be the most late maturing genotype.

Three genotypes *viz.,* Deval (101.67days), Roda Dhan (102 days) and Doda Dhan (102 days) were found to be significantly early maturing in comparison to the best check HPR-2795 (108 days). While, seventeen genotypes Bathi Dhan, Kalijhini-2, Nailina, IC-12164, HPR-2906, Chohartu, HPR-2908, Kalijhini, Ramjuwain, HPR-2904, IC-12180, Kaluna, HPR-2800, Hatiali, Bhrigu Dhan, HPR-2902 and Matali were considered statistically at par with the HPR-2795.

#### *c) Plant Height [cm]*

Plant height among the genotypes was found to be ranged between **98.07cm to 166.50cm**with mean height of **137.95cm**. Among all the genotypes, Kaluna was observed with shortest plant height and genotype HPR-2902 was observed with highest plant height.

Out of thirty-two genotypes, six genotypes Kaluna (98.07cm), HPR-2914 (107.83cm), HPR- 2908 (108.43cm), IC-12164 (112.93cm), Karad (122.13cm) and Bathi Dhan (122.23cm) were considered significantly shortest in plant height in comparison to best check HPR-2720 (137.50cm). While, eighteen genotypes Matali, Deval, Naggar Dhan, Ramjuwain, HPR-2905, Kalaina, Roda Dhan, Hatiali, Nailina, Kalijhini, Begmi, Gocha, Sukara red, HPR-2800, Kalijhini-2, HPR-2913, HPR-2906 and Desi Dhan were found to be statistically at par with HPR-2720.

#### *d) Flag leaf length [cm]*

Flag leaf length varied from **26.53cm to 64.43cm** with mean length of **43.69cm**. Genotype HPR-2913 was found to have highest flag leaf length. While, Bathi Dhan was having lowest flag leaf length.

Among thirty-two genotypes, none of the genotype was found to be significantly superior to the best check HPR-2795 (62.83cm) but, six genotypes HPR-2913, Desi Dhan, IC-12180, Sukara red, Ramjuwain and Kalijhini-2were found statistically at par with it.

#### *e) Flag leaf width [cm]*

Flag leaf width ranged between**1.27cm to 2.27cm** with mean value of **1.66cm**. The highest flag leaf length was observed in Acchoo and lowest in genotype Roda Dhan.

None of the genotype was found to be significantly superior for flag leaf width to the best HPR-2795 (2.03cm). However, twelve genotypes Acchoo, HPR-2904, IC-12180, Chohartu, Kalijhini, HPR-2908, Hatiali, HPR-2902, HPR-2905, Deval, Kaluna and Bhrigu Dhan were found to be statistically at par with HPR-2795.

#### *f) Total tillers per plant*

Total tillers per plant among the genotypes ranged between **3.67 to 12.27** with mean value of **7.55**. Among all the genotypes, HPR-2908 exhibited highest total tiller per plant and Chohartu exhibited lowest total tiller per plant.

Out of thirty-two genotypes, none of the genotype was statistically superior to the best check HPR-2720 (12.27) but HPR-2908 found to be statistically at par with best check. Rest of the genotypes were statistically inferior for total tillers per plant.

*g) Effective tillers per plant*

Effective tillers per plant among the genotypes studied were observed in the range of **3.60 to 12.20** with mean value of **6.80**. The highest effective tillers per plant were reported in genotype HPR-2908 and lowest value was recorded in the genotype Chohartu.

Among thirty-two genotype, HPR-2908 (12.20) was found to be significantly superior in comparison to the best check HPR-2720 (9.93). Four genotypes Kaluna, HPR-2914, Gocha and Roda Dhan were found to be statistically at par with HPR-2720.

*h) Spikelets per panicle*

Spikelets per panicle were found to be ranged from **34.60 to 89.33** with mean value of **59.54**. The highests pikelets per panicle were observed in HPR-2913 and lowest spikelets per panicle were reported in genotype Karad.

None of the genotypes among the thirty-two were found to be significantly superior in comparison to the best check HPR-2795 (89.33). However, four genotypes HPR-2913, HPR-2908, HPR-2914 and HPR-2905 were found to be statistically at par with HPR-2795.

*i) Thousand grain weight [g]*

Thousand grain weight was found to be ranged from **16.56g to 35.23g** with mean weight of **23.90g**. Among the genotypes, Doda Dhan exhibited highest thousand grain weight. Lowest thousand grain weight was reported in Begmi.

Among thirty-two, none of the genotypes was found to be significantly superior in comparison to the best check Varun Dhan (35.23g). However, one genotype Doda Dhan was found to be statistically at par with Varun Dhan for this trait.

*j) Harvest index [%]*

Harvest index varied from **33.61% to 65.54%** with the mean value of**52.04%**. Genotype Chohartu was found to have highest harvest index percent among the genotypes studied. Simultaneously, lowest harvest index percent was reported in genotype HPR-2906.

One genotype *viz.,* Chohartu (65.54%) was found to be significantly superior in comparison to the best check HPR-2795 (52.77%). However, twenty-five genotypes Sukara, Kalaina, Doda Dhan, HPR-2902, IC-12180, Matali, Begmi, Bathi Dhan, HPR-2914, HPR-2908, HPR-2913, Acchoo, Karad, Gocha, IC-12164, Kalijhini-2, Ramjuwain, HPR-2905, HPR-2800, Desi Dhan, Roda Dhan, Sukara red, Kaluna, Deval and Kalijhini were found to be statistically at par with HPR-2795 for this particular trait.

*k) Grain yield per plant [g]*

Grain yield per plant ranged between **8.47g to 21.73g** with mean value of **12.61g**. Among all the genotypes taken in the present study, genotype HPR-2913 was found to have highest grain yield per plant. However, lowest grain yield per plant was reported in the genotype Kaluna.

Among all thirty-two genotypes HPR-2913(21.73g) was found to be significantly superior in comparison to the best check HPR-2795 (17.53g). Two genotypes IC-12180 and Desi Dhan were statistically at par with HPR-2795 for grain yield per plant.

*3.3.2 Grain quality traits*

*a) Grain length [mm]*

Grain length was found to be ranged between **5.31mm to 7.21mm** with mean value of **5.99mm**. Among all the genotype HPR-2908 was found to have longest grain and IC-12164 had shortest grain. Out of thirty-two genotypes taken in present study, four genotypes HPR-2908 (7.21mm), HPR-2800 (6.94mm), Bhrigu Dhan (6.87mm) and HPR-2906 (6.73mm) were found significantly superior in comparison to the best check HPR-2795 (6.35mm). While, nine genotypes HPR-2913, HPR-2902, Doda Dhan, Desi Dhan, Sukara red, Acchoo, Chohartu, Hatiali and Deval were found to be statistically at par with HPR-2795 for grain length.

b) Grain Breadth [mm]

Grain breadthranged between **1.75mm to 2.30mm** with mean value of **2mm**. Genotype Dodadhan was found to have highest grain breadth among all the genotype. While, genotype Kalijhini-2 was found to had lowest grain breadth among all the genotype taken in the present study.

Only one genotype *viz.,* Doda Dhan (2.44mm) was found to be significantly superior in comparison to the best check

Table. 3.3 (a) Mean performance of genotypes for various traits

| S.No. | Genotypes | Days to 50% flowering | Days to 75% maturity | Plant Height (cm) | Flag Leaf Length (cm) | Flag leaf Width (cm) | Total Tiller per plant | Effective Tillers per plant | Spikelets per panicle | Thousand grain weight (g) | Harvest Index (%) | Grain yield per plant (g) | Grain length (mm) | Grain breadth (mm) | Grain L:B ratio |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | **IC-12180** | 82.33 | 110.00 | 159.70 | 62.70 | 2.13 | 7.87 | 6.67 | 64.13 | 25.03 | 56.98 | 19.37 | 5.77 | 1.97 | 2.92 |
| 2 | **KALUNA** | 82.00 | 110.67 | **98.07*** | 44.90 | 1.83 | 10.37 | 10.17 | 66.20 | 20.60 | 46.68 | 8.47 | 5.36 | 1.87 | 2.86 |
| 3 | **RAMJUWAIN** | 79.33 | 109.67 | 129.97 | 53.40 | 1.50 | 6.30 | 6.13 | 41.23 | 22.24 | 53.31 | 11.43 | 5.83 | 1.98 | 2.94 |
| 4 | **CHOHARTU** | 77.67 | 108.00 | 156.43 | 41.30 | 2.10 | 3.67 | 3.60 | 41.13 | 27.97 | **65.54** | 12.30 | 6.12 | 2.04 | 3.01 |
| 5 | **SUKARA** | 91.33 | 115.33 | 153.40 | 49.57 | 1.63 | 8.13 | 7.77 | 55.30 | 18.32 | 63.24 | 15.27 | 5.70 | 1.91 | 2.99 |
| 6 | **KARAD** | 91.67 | 116.00 | **122.13*** | 44.17 | 1.40 | 5.77 | 5.40 | 34.60 | 19.12 | 54.12 | 12.10 | 5.44 | 1.93 | 2.81 |
| 7 | **KALAINA** | 89.00 | 114.00 | 133.40 | 35.63 | 1.33 | 7.70 | 6.83 | 50.73 | 22.35 | 60.57 | 12.47 | 5.44 | 2.05 | 2.65 |
| 8 | **IC-12164** | 76.33 | 106.67 | **112.93*** | 44.50 | 1.33 | 6.73 | 6.53 | 52.67 | 20.14 | 53.66 | 9.70 | 5.31 | 2.00 | 2.65 |
| 9 | **ACCHOO** | 91.33 | 115.00 | 155.00 | 47.70 | 2.27 | 4.57 | 4.13 | 42.97 | 21.24 | 54.92 | 13.23 | 6.12 | 1.84 | 3.31 |
| 10 | **BEGMI** | 90.00 | 120.33 | 136.17 | 38.50 | 1.40 | 6.20 | 5.40 | 53.43 | 17.29 | 55.93 | 10.93 | 5.91 | 1.80 | 3.28 |
| 11 | **BATHI DHAN** | 75.33 | 105.00 | **122.23*** | 26.53 | 1.33 | 4.33 | 3.73 | 35.57 | 28.10 | 55.48 | 14.03 | 5.69 | 2.30 | 2.48 |
| 12 | **HPR-2906** | 77.00 | 107.33 | 146.87 | 38.10 | 1.70 | 5.50 | 4.70 | 40.63 | 24.20 | 33.61 | 10.33 | **6.73*** | 1.91 | **3.50*** |
| 13 | **DESI DHAN** | 89.00 | 121.33 | 148.80 | 64.20 | 1.50 | 6.90 | 5.90 | 57.20 | 25.74 | 51.06 | 18.97 | 6.20 | 1.99 | 3.10 |
| 14 | **KALIJHINI-2** | 74.33 | 105.33 | 145.83 | 52.10 | 1.33 | 8.50 | 8.10 | 70.57 | 17.46 | 53.48 | 11.50 | 5.84 | 1.75 | 3.33 |
| 15 | **SUKARA RED** | 93.00 | 123.67 | 140.27 | 53.53 | 1.40 | 5.83 | 4.70 | 45.93 | 26.52 | 46.75 | 16.83 | 6.18 | 1.97 | 3.13 |
| 16 | **HATIALI** | 88.00 | 111.33 | 133.87 | 41.53 | 1.97 | 8.37 | 7.60 | 71.37 | 23.73 | 45.52 | 9.77 | 6.02 | 1.93 | 3.12 |
| 17 | **HPR-2800** | 82.33 | 110.67 | 143.13 | 36.70 | 1.67 | 7.10 | 6.27 | 53.87 | 24.38 | 52.42 | 13.33 | **6.94*** | 1.91 | **3.64*** |
| 18 | **NAGGAR DHAN** | 89.00 | 120.33 | 128.13 | 42.17 | 1.47 | 6.70 | 6.37 | 60.63 | 27.41 | 43.39 | 10.50 | 5.64 | 2.05 | 2.74 |
| 19 | **RODA DHAN** | 71.67 | **102.00*** | 133.40 | 33.20 | 1.20 | 9.10 | 8.57 | 71.17 | 29.35 | 48.07 | 10.57 | 5.92 | 2.26 | 2.62 |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **20** | **NAILINA** | 76.33 | 106.33 | 134.43 | 36.13 | 1.60 | 10.43 | 6.63 | 63.90 | 24.02 | 43.04 | 11.27 | 5.32 | 2.04 | 2.61 |
| **21** | **DEVAL** | 71.67 | **101.67*** | 124.83 | 36.43 | 1.83 | 6.20 | 6.00 | 47.33 | 27.24 | 46.49 | 8.93 | 6.02 | 2.22 | 2.71 |
| **22** | **BHRIGU DHAN** | 80.33 | 110.67 | 159.67 | 38.30 | 1.73 | 7.37 | 6.63 | 48.43 | 24.74 | 44.74 | 9.53 | 6.87 | 2.02 | **3.40*** |
| **23** | **KALIJHINI** | 77.33 | 108.67 | 136.10 | 41.67 | 2.00 | 7.87 | 7.33 | 56.17 | 18.45 | 45.90 | 13.23 | 5.94 | 1.81 | 3.28 |
| **24** | **MATALI** | 88.00 | 112.67 | 124.63 | 40.73 | 1.43 | 6.23 | 6.13 | 76.13 | 22.54 | 56.88 | 12.33 | 5.60 | 2.01 | 2.79 |
| **25** | **DODA DHAN** | 72.33 | **102.00*** | 151.23 | 37.67 | 1.63 | 8.77 | 8.13 | 63.20 | 33.69 | 60.12 | 14.37 | 6.21 | **2.44*** | 2.54 |
| **26** | **HPR-2902** | 84.00 | 111.33 | 166.50 | 42.60 | 1.93 | 5.43 | 5.13 | 48.37 | 24.38 | 58.58 | 11.20 | 6.55 | 2.00 | 3.27 |
| **27** | **HPR-2904** | 84.00 | 110.00 | 154.10 | 36.50 | 2.20 | 5.57 | 4.93 | 63.40 | 25.96 | 43.41 | 10.43 | 5.99 | 2.04 | 2.94 |
| **28** | **HPR-2905** | 91.67 | 120.33 | 132.50 | 39.63 | 1.90 | 6.13 | 5.40 | 77.77 | 17.71 | 52.89 | 9.60 | 5.87 | 1.82 | 3.21 |
| **29** | **HPR-2908** | 82.33 | 107.67 | **108.43*** | 33.17 | 1.97 | 12.27 | **12.20*** | 83.50 | 24.32 | 54.89 | 12.25 | **7.21*** | 1.99 | **3.62*** |
| **30** | **HPR-2913** | 89.00 | 115.33 | 141.20 | 64.43 | 1.50 | 6.90 | 6.63 | 86.10 | 25.81 | 54.48 | **21.73*** | 6.56 | 2.06 | 3.19 |
| **31** | **HPR-2914** | 90.00 | 117.00 | **107.83*** | 38.20 | 1.27 | 10.53 | 9.80 | 81.27 | 24.32 | 55.43 | 13.50 | 5.55 | 2.12 | 2.61 |
| **32** | **GOCHA** | 84.00 | 117.00 | 136.43 | 44.37 | 1.33 | 9.83 | 8.90 | 64.63 | 24.03 | 53.77 | 11.63 | 5.53 | 1.97 | 2.81 |
| **33** | **HPR-2720 (C)** | 94.00 | 124.33 | **137.50** | 46.87 | 1.90 | **12.27** | **9.93** | 64.07 | 16.56 | 50.64 | 9.43 | 5.71 | 1.77 | **3.23** |
| **34** | **HPR-2795 (C)** | 89.00 | **108.00** | 156.53 | **62.83** | **2.03** | 10.40 | 8.57 | **89.33** | 26.12 | **52.77** | **17.53** | **6.35** | 2.00 | 3.18 |
| **35** | **VARUN DHAN (C)** | **73.33** | 108.33 | 156.57 | 39.17 | 1.40 | 8.40 | 7.23 | 61.00 | **35.23** | 48.78 | 10.40 | 6.30 | **2.23** | 2.83 |
| | **Total** | 2917.97 | 3913.99 | 4828.21 | 1529.13 | 58.14 | 264.24 | 238.14 | 2083.93 | 836.31 | 1817.54 | 438.46 | 209.74 | 70.00 | 105.30 |
| | **Mean total** | 83.34 | 111.82 | 137.95 | 43.69 | 1.66 | 7.55 | 6.80 | 59.54 | 23.90 | 52.04 | 12.61 | 5.99 | 2.00 | 3.01 |
| | **C.D.** (5%) | 4.01 | 5.60 | 13.07 | 11.08 | 0.32 | 1.67 | 1.62 | 11.67 | 1.69 | 10.62 | 3.69 | 0.34 | 0.12 | 0.16 |
| | **C.V.** (%) | 2.95 | 3.07 | 5.80 | 15.54 | 11.70 | 13.56 | 14.58 | 12.00 | 4.33 | 12.49 | 17.90 | 3.50 | 3.52 | 3.17 |

* Significantly superior over the best check

Varun Dhan (2.23mm). However, four genotype Bathi Dhan, Roda Dhan, Deval and HPR-2914 were found to be statistically at par with Varun Dhan for the trait of grain breadth.

*c) L:B ratio*

L:B ratio was found to be ranged between **2.48 to 3.64** with mean value of**3.01**. The grain L:B ratio among the studied genotypes was highest in HPR-2800 and lowest was reported in Bathi Dhan.

Four genotypes *viz.,* HPR-2800 (3.64), HPR-2908 (3.62), HPR-2906 (3.50) and Bhrigu Dhan (3.40) were observed to be significantly superior in comparison to the best check HPR-2720 (3.23). However, ten genotype Kalijhini-2, Acchoo, Kalijhini, Begmi, HPR-2902, HPR-2905, HPR-2913, Sukara red, Hatiali and Desi Dhan found to be statistically at par with HPR-2720 for the grain L:B ratio.

*d) Lodging effect (%)*

Effect of lodging in traditional landraces is always a major drawback but in present study twenty-five traditional red rice genotypes found to be lodging resistant.

*e) Awns*

Characteristics of presence of awns in red rice genotypes were reported in sixteen genotypes and rest of the genotypes were awn less as reported in Slide 3.2

*f) Seed coat colour*

Colour of seed coat in present study was found to be dark red coloured in thirty-four genotypes. However, one genotype was reported to be light red coloured which is presented in Slide 3.1

Table 3.3 (b) Classification of grain length on present studied genotypes

| S. No | Grain classification | Grain size | No. of genotypes | Genotypes |
|---|---|---|---|---|
| 1 | Extra long | >7mm | 1 | HPR-2908 |
| 2 | Long | 6-7mm | 14 | Chohartu, Acchoo, HPR-2906, Desi Dhan, Sukara red, Hatiali, HPR-2800, Deval, Bhrigu Dhan, Doda Dhan, HPR-2902, HPR-2913, HPR-2795, Varun Dhan |
| 3 | Medium | 5-5.9mm | 20 | IC-12180, Kaluna, Ramjuwain, Sukara, Karad, Kalaina, IC-12164, Begmi, Bathi Dhan, Kalijhini-2, Naggar Dhan, Roda Dhan, Nailina, Kalijhini, Matali, HPR-2904, HPR-2905, HPR-2914, Gocha, HPR-2720 |
| 4 | Short | <5mm | - | - |

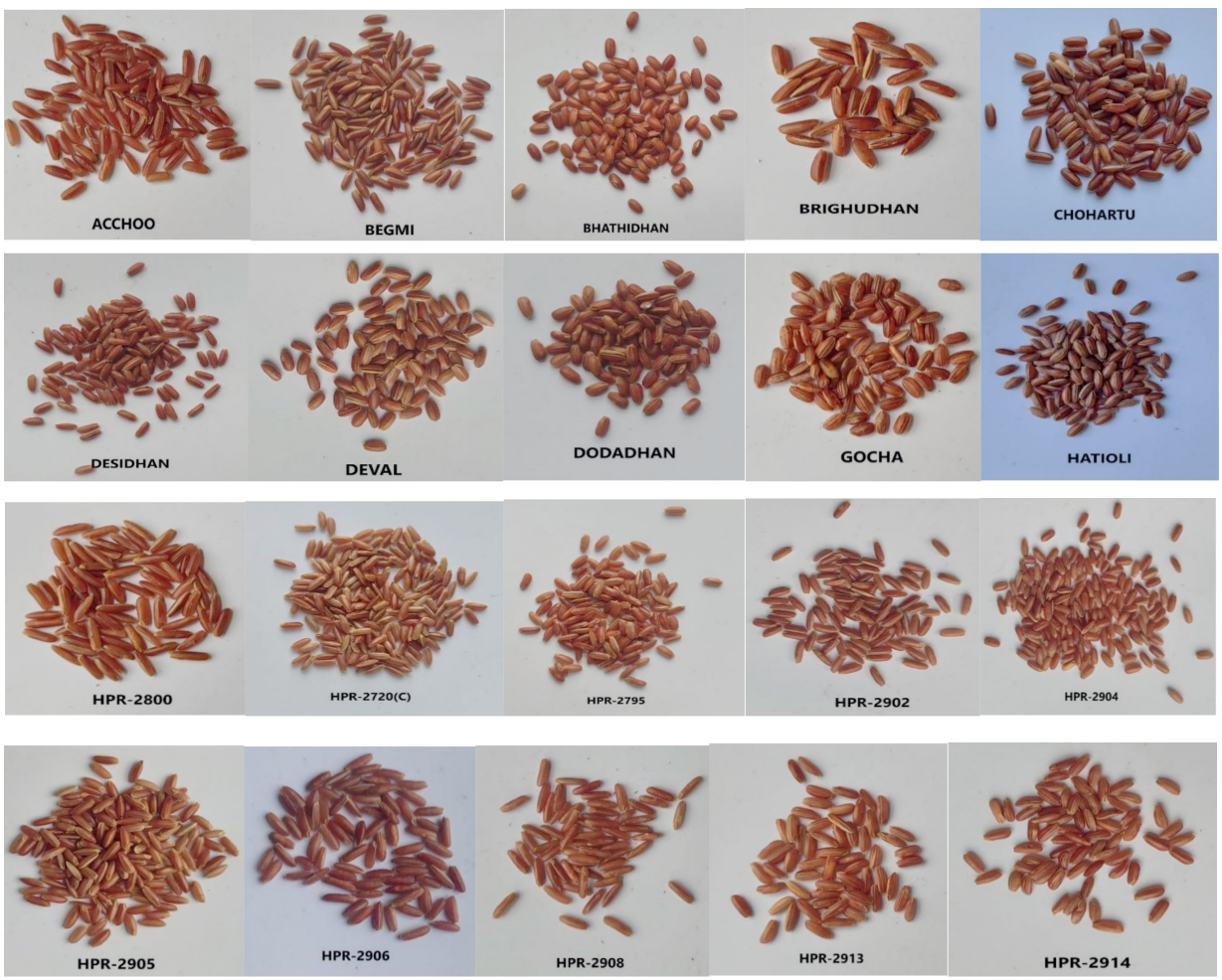
Table 3.3 (c) Classification of grain L:B ratio on present studied genotypes

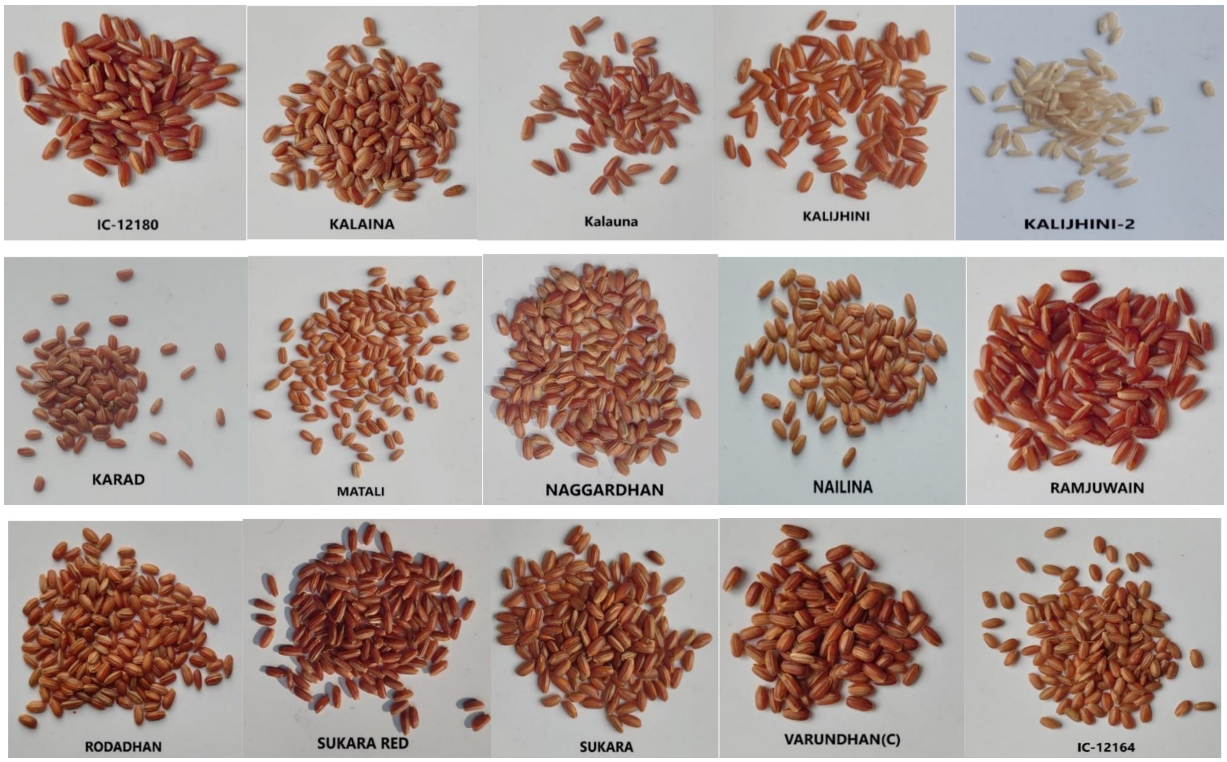
| S. No | Grain classification | Grain size | No. of genotypes | Genotypes |
|---|---|---|---|---|
| 1 | Slender or fine | >3 | 17 | Kalijhini, Bhrigu Dhan, HPR-2902, HPR-2905, HPR-2908, HPR-2913, HPR-2720, HPR-2795, Chohartu, Acchoo, Begmi, HPR-2906, Desi Dhan, Kalijhini-2, Sukara red, Hatiali, HPR-2800 |
| 2 | Medium slender or medium fine | 2.4 - 3 | 18 | Deval, Matali, Doda Dhan, HPR-2904, Varun Dhan, Gocha, HPR-2914, IC-12180, Kaluna, Ramjuwain, Sukara, Karad, Kalaina, IC-12164, Bathi Dhan, Naggar Dhan, Roda Dhan and Nailina |
| 3 | Coarse or bold | 2.0 -2.39 | - | - |
| 4 | Round | <2 | - | - |

Table3.3 (d): Disease reaction to leaf and neck blast

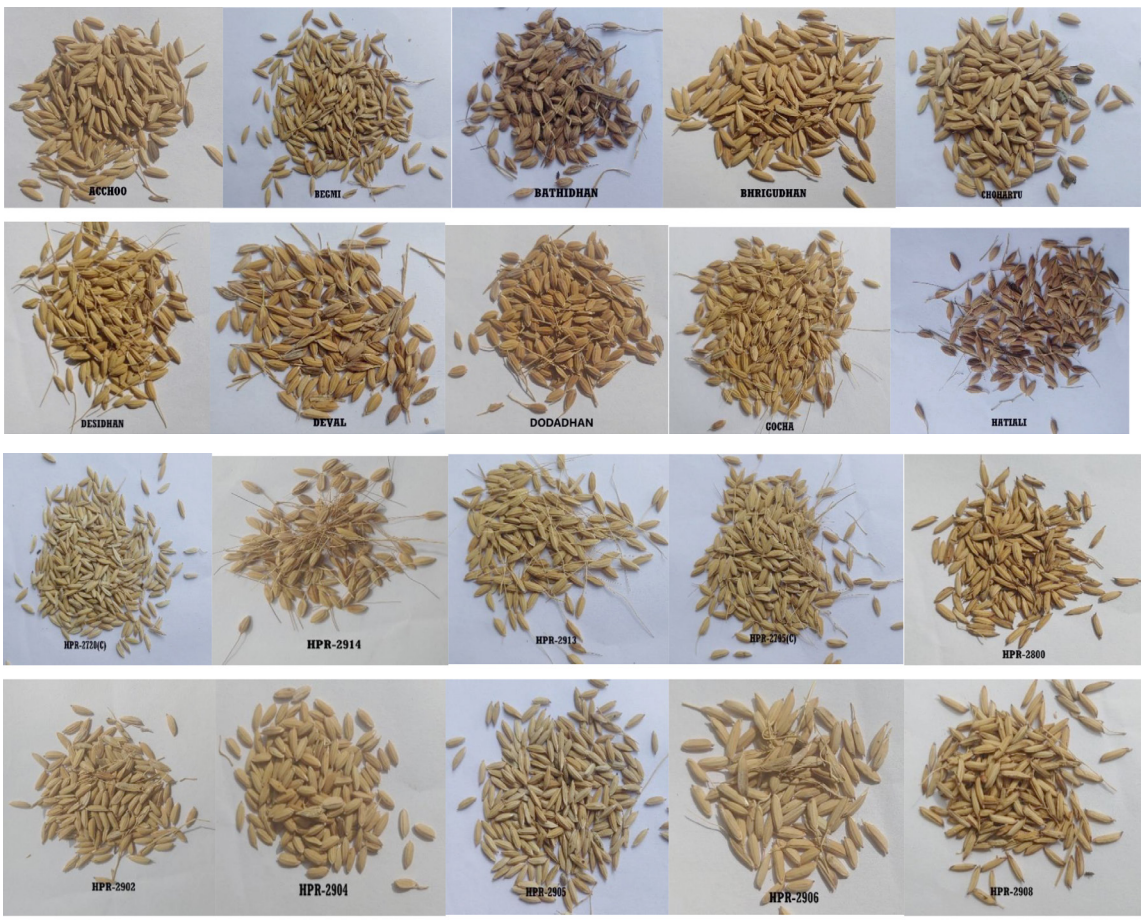
| | Reaction to Neck blast under field condition | | Reaction to Leaf blast under field condition |
|---|---|---|---|
| **Scale** | **Description** | **Genotypes** | **Genotypes** |
| 0 | Immune | - | - |
| 1 | Resistant | IC-12180, HPR-2800, HPR-2795, HPR-2914, HPR-2913 | IC-12180, HPR-2800, HPR-2795, HPR2913, HPR-2914 |
| 3 | Moderately Resistant | HPR-2720, HPR-2913 | HPR-2720, HPR-2913, Begmi |
| 5 | Moderately Susceptible | IC-12164, Bathi Dhan, Doda Dhan, Begmi, Ramjuwain, Kalaina, Bhrigu Dhan, Deval, Chohartu, Sukara Red, Kalijhini, Desi Dhan, HPR-2902, HPR-2908, HPR-2904, HPR-2905, Sukara, Varun Dhan | IC-12164, Kalhaina, Bathidhan, Doda Dhan, Ramjuwain, Karad, Sukara, Varun Dhan, Chohartu, Sukara Red, Kalijhini, Desi Dhan, HPR-2902, HPR-2908, HPR-2904, HPR-2905. |
| 7 | Susceptible | Kaluna, Roda Dhan, Acchoo, Karad, Gocha, Kalijhini-2, Hatiali, Naggar Dhan, Nailina, Matali, HPR-2906. | Kaluna, Acchoo, Gocha, Kalijhini 2, Naggar Dhan, Nailina, Hatiali, Matali, HPR-2906, Roda Dhan, Deval, Bhrigu Dhan |
| 9 | Highly Susceptible | - | - |

Slide 3.1 Seed coat colour






Slide. 3.2 Awns



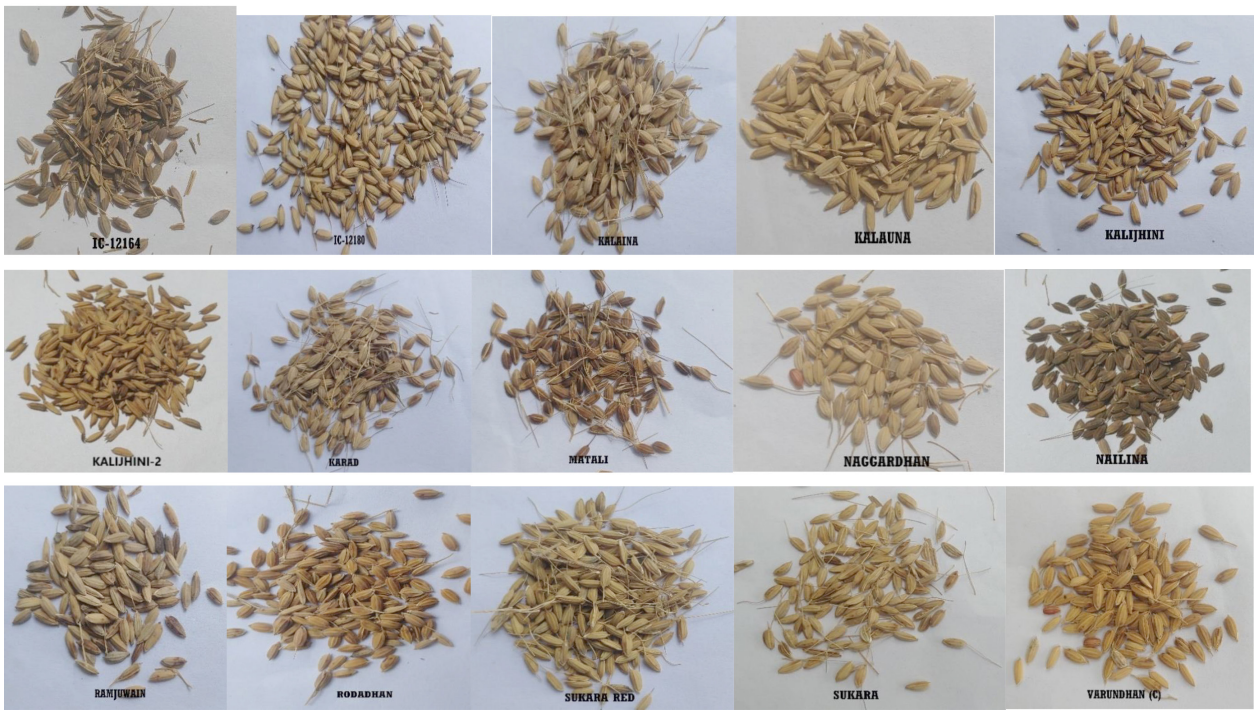



Table 3.3 (d): Promising genotypes on the basis of mean performance for seed yield and other related traits

| S. No | Traits | Significantly superior genotype to best check | Genotype statistically at par with bestcheck |
|---|---|---|---|
| 1 | Days to 50% flowering | - | Bathi Dhan, HPR-2906, Kalijhini-2, Roda Dhan, Nailina, Deval, kalijhini, Doda Dhan |
| 2 | **Days to 75% maturity** | Deval, Roda Dhan and Doda Dhan | IC-12180, Kaluna, Ramjuwain, Chohartu, IC-12164, Bathi Dhan, HPR-2906, Kalijhini-2, Hatiali, HPR-2800, Nailina, Bhrighu Dhan, Kalijhini, Matali, HPR-2902, HPR-2904, HPR-2908 |
| 3 | **Plant height** | Kaluna, HPR-2914, HPR-2908, IC-12164, Karad, Bathi Dhan. | Ramjuwain, Kalaina, Begmi, HPR-2906, Desi Dhan, Kalijhini-2, Sukara red, Hatiali, HPR-2800, Naggar Dhan, RodaDhan, Nailina, Deval, Kalijhini, Matali, HPR-2905, HPR-2913, Gocha |
| 4 | **Flag leaf length** | - | HPR-2913, IC-12180, Ramjuwain, Desi Dhan, Kalijhini-2, Sukara red |
| 5 | **Flag leaf width** | - | Acchoo, IC-12180, Kaluna, Chohartu, Hatiali, Deval, Bhrigu Dhan, Kalijhini, HPR-2902, HPR-2904, HPR-2905, HPR-2908 |
| 6 | **Total tillers per plant** | | HPR-2908 |
| 7 | **Effective tillers per plant** | HPR-2908 | Kaluna, Rodadhan, HPR-2914, Gocha |
| 8 | **Spikelets per panicle** | - | HPR-2913, HPR-2908, HPR-2914, HPR-2905 |
| 9 | **Thousand grain weight** | - | Doda Dhan |
| 10 | **Harvest index** | Chohartu | IC-12180, Kaluna, Ramjuwain, HPR-2902, Sukara, Karad, Kalaina, IC-12164, Acchoo, Begmi, Bathi Dhan, Desi Dhan, Kalijhini-2, Sukara red, HPR-2800, Roda Dhan, Deval, Kalijhini, Matali, Doda Dhan, HPR-2902, HPR-2905, HPR-2908, HPR-2913, HPR-2914, Gocha |

| | | | |
|---|---|---|---|
| 11 | **Grain yield per plant** | HPR-2913 | IC-12180, Desi Dhan, Doda Dhan |
| 12 | **Grain length** | HPR-2908, HPR-2800, Bhrigu Dhan, HPR-2906 | Chohartu, Acchoo, Desi Dhan, Sukara red, Hatiali, Deval, Doda Dhan, HPR-2902, HPR-2913 |
| 13 | **Grain breadth** | Doda Dhan | Bathi Dhan, Rodadhan, Deval, HPR-2914 |
| 14 | **Grain L:B ratio** | HPR-2800, HPR-2908, HPR-2906, Bhrigudhan | Acchoo, Begmi, Desi Dhan, Kalijhini-2, Sukara red, Hatiali, Kalijhini, HPR-2902, HPR-2905, HPR-2913 |
| 15 | **Lodging effect (Zero lodging effect )** | Begmi, HPR-2906, Kalijhini-2, Sukara red, Hatiali, HPR-2800, Naggar Dhan, Roda Dhan, Nailina, Deval, Bhrighu Dhan, Kalijhini, Matali, Doda Dhan, HPR-2902, HPR-2904, HPR-2905, HPR-2908, HPR-2913, HPR-2914, HPR-2914, Gocha, HPR-2720, HPR-2795, Varun Dhan | |
| 16 | **Disease reaction (resistant for both leaf and neck blast)** | IC-12180, HPR-2800, HPR-2795, HPR2913, HPR-2914 | |

### *3.3.3 Reaction to leaf and Neck blast:*

Rice blast disease is one of the most destructive diseases of rice around the world. The pathogen is most common on leaves, during vegetative stage causing leaf blast. The neck blast appears on nodes and panicle branches during the reproductive stage (Bonman 1992). The various studies reported that panicle and neck blast incidence is linearly related to yield loss. (Tsai 1988; Torres and Teng 1993). Further leaf blast lesions reduce the net photosynthetic rate of individual leaves to an extent far beyond the visible diseased leaf fraction (Bastiaans 1991). In the present study the symptoms of leaf and neck blast were evaluated under open field conditions and it was found that the genotypes IC-12180, HPR-2800, HPR-2795, HPR-2913 and HPR-2914 showed small brown specks without sporulating center and: neck blast symptoms less than 5% were observed in genotypes IC-12180, HPR-2800, HPR-2795, HPR-2913 and HPR-2914 and these genotypes were found to be the resistance for both leaf and neck blast as reported in table 3.3 (d).

## 4. Conclusion

The present study revealed that, genotype- Deval, HPR-2913, HPR-2908 were found to be promising for most of the traits including grain quality thus, these genotypes can be either released as varieties after multilocation testing or can be considered for future rice breeding programme. The genotypes, IC-12180, HPR-2800, HPR-2795, HPR2913, HPR-2914 were found to be resistance to both leaf and neck blast under open field conditions. Besides this, genotype IC-12180 also expressed superiority for fewer traits which can also be used in rice breeding programme for improvement of existing genotypes. High heritability coupled with high genetic advance as percent of mean was reported for biological yield per plant, thousand grain weight and grain L:B ratio which indicated presence of high additive gene action envisaging thereby that the selection for these traits will be useful.

## 5. Reference


1. Anonymous. 2012. The Hindu, The Hindu Group, From 1,10,000 varieties of rice to only 6,000 now. http://www.thehindu.com/news/national/karnataka/from-110000-varities-of-rice-to-only-6000-now/article3284453.
2. Anonymous. 2021. World agriculturalproduction. USDA-Foreign Agricultural Service. https://apps.fas.usda.gov/psdonline/circulars/production.pdf**.**
3. Bagudam R, Eswari KB, Badri J and Rao PR. 2018. Correlation and path analysis for yield and its component traits in NPT core set of rice (*Oryza sativa L.*). *International Journal of Current Microbiology and Applied Science***7**: 97-108.
4. Bastiaans L and Kropff MJ. 1993. Effects of leaf blast on photosynthesis of rice 2. canopy photosynthesis. *Netherland Journal of Plant Pathology***99**: 205- 217.

5. Bonman JM. 1992. Blast. In: Compendium of Rice Diseases, *The American Phyto pathological Society*, St. Paul, Minnesota, USA, pp. 14-16.

6. Burton GW and DeVane EH. 1953. Estimating heritability in tall Fescue (*Festuca arundinacea*) from replicated colonal material. *Agronomy Journal***45**: 310-314.

7. IRRI. 2013. Standard Evaluation System (SES) for Rice, International Rice Research Institute, Los Banos, Philippines, 5th edition.

8. Johnson HW, Robinson HF and Comstock RE. 1955. Estimates of genetic and environmental variability in soybeans. *Agronomy Journal***47**: 314-318

9. Kaushik RP, Shekhar J and Ajai Srivastava. 2014. Status Paper on Rice in Himachal Pradesh. Rice Knowledge Management Portal. http://www.rkmp.co.in.

10. Kujur MJ, Koutu GK, Krishnan RS and Singh Y. 2019. Genetic variability of agro-morphological traits in traditional varieties of rice (*Oryza sativa L.*) from Madhya Pradesh, India. *International Journal of Chemical Studies***6**: 1693-700.

11. Kumar B. 2020. An appraisal of genetic variability and diversity among traditional red rice landraces. *International Journal of Ecology and Environmental Sciences* **2**: 177-181.

12. Kumaresan D and Manonmani S. 2019. Assessment of Genetic Variability for Qualitative and Quantitative Traits in Local Rice Cultivars of Gudalur Valley of the Nilgiris. *Indian Journal of Pure Applied Bioscience***7**: 237-245.

13. Panse VG and Sukhatme PV. 1989. Statistical methods for agricultural workers. New Delhi: Indian Council of Agricultural Research.

14. Raghuvanshi RS, Dutta A, Tewari G and Suri S. 2017. Qualitative characteristics of red rice and white rice procured from local market of Uttarakhand: a comparative study. *Journal of Rice Research***10**: 49-53.

15. Torres CQ and Teng PS. 1993. Path coefficient and regression analysis of the effects of leaf and panicle blast on tropical rice yield. *Crop Protect***12**: 296-302.

16. Tsai WH. 1988. Estimation of rice yield losses caused by panicle blast disease. *Journal of Agricultural Research of China* **37**: 86-90.