Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2018; 7(5): 3102-3106
Received: 20-07-2018
Accepted: 21-08-2018

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# Assessment of rice germplasm lines for leaf blast resistance and yield related parameters under blast hot spot locality

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## Abstract
Rice serves as a pillar for food security in many developing countries. The biotic and abiotic stress is adversely affects the rice production; especially rice blast is one of the critical limiting factors responsible for reduction in rice production. In present study, germplasm lines were screened for leaf blast reaction and their per se performance assessed for yield and yield related parameters under blast hot spot conditions. A total of 35 germplasm lines were screened during *Kharif* 2014 for blast resistance under field conditions by UBN technique at AHRS, Ponnampet. The resistant checks (Tadukan and Tetep), shown highly resistant response, KPR-1, KPR-2, Kiruwana and IR-64 recorded resistant response and whereas Jaya, Intan, Ambemori, Bheemasaali, Chittiga and FR-13A were recorded highly susceptible to the leaf blast along with susceptible checks (CO-39 and HR-12). The analysis of variance revealed significant differences among the genotypes for all the studied characters. The landrace Kiruwana recorded highest seed yield per plant followed by Tunga, whereas the check entry HR-12 recorded lowest seed yield per plant followed by Jeerige sanna. The resistant genotypes identified through screening and *per se* performance can be used further for development of leaf blast resistant high yielding genotypes.

**Keywords:** Germplasm, screening, *Per se* performance, blast, resistance

## Introduction
Rice was the first sequenced crop genome with estimated genome size of 430 Mb (Jackson, 2016). It is the one of the world's most stable food crop for over half of the world's population (Khush, 2005) and serves as a pillar for food security in many developing countries. The year, 2004 was declared as International Year of Rice by the United Nations Food and Agriculture Organization by considering its importance. The green revolution in the 1960's increased world rice production. On contrary the production potential of modern cultivars of rice is currently declining, because of several biotic and abiotic stresses (Keneni *et al.*, 2012) [12]. Among the major diseases, rice blast ranks first in reducing yield because of its wide distribution and high destructiveness under favorable conditions (Ou, 1985) [14]. Blast is caused by fungi, *Magnaporthe grisea* (Herbert) Borr. (anamorph = *Pyricularia grisea*). Blast occurs in different environments and causing significant problem in temperate regions. This can also cause problem in areas such as irrigated lowland and upland (Kuyek, 2000) [13]. Conditions conducive for rice blast include long periods of free moisture where leaf wetness is required for infection and high humidity is common. Initially blast symptoms appear as small necrotic lesions in rice seedlings later become larger and spreads to other parts of the plant (Galhano and Talbot, 2011) [5] at any growth stage and can cause severe leaf necrosis and impede grain filling, resulting in decreased grain number and weight. The fungus causes partial to complete sterility when the last node is attacked.

There are various methods used for managing rice blast *viz.*, use of resistant varieties, cultural practices, biological and chemical control. However, the development of disease resistant cultivars is considered to be the most eco-friendly and practical approach to manage the disease. The Durable wide spectrum resistance to blast in rice cultivars accomplished by accumulating both qualitative and quantitative resistance genes in to rice cultivars (Joshi *et al.*, 2009) [11]. Introducing these resistance genes from the wild relatives of rice into commercial cultivars has greatly helped the breeders to accomplish this task. Therefore, exploitation of resistance gene resources or wild relatives of rice are valuable and have been used in rice breeding programs.

**Materials and methods**

Totally 35 rice germplasm lines comprising, 15 landraces, 16 popular varieties, two susceptible (CO-39 and HR-12) and two resistant national checks (Tadukan and Tetep) were utilized to screen for leaf blast resistance at AHRS, Ponnampet during *Kharif* 2014. Rice germplasm lines were sown in two replications for blast disease reaction using Uniform Blast Nursery (UBN). Where, nursery beds were raised of 0.50 m width with 50.00 m length under upland conditions and two rows of most susceptible checks were sown all along the borders to serve as a source of inoculums for spreading the disease. Each germplasm line was planted in single row of 50 cm length with a row spacing of 10 cm. The susceptible and resistant checks were sown after every 10 rows of test material. Infected leaves, nodes and panicles were chopped and spread in spreader rows to establish disease in the nursery. Disease reactions were scored with 0–9 scale (SES, IRRI, 1996) after observing disease symptoms on most susceptible checks. The germplasm line exhibiting reactions of score 0 to 1 were considered as highly resistant, 2 as resistant, 3-4 as moderately resistant, 5-6 as moderately susceptible, 7 as susceptible and while those showing reactions that scored 8–9 were highly susceptible (IRRI, 1996).

The germplasm also evaluated in the main field with two replications in RCBD fashion to study *per se* performance of germplasm. Observations on growth and yield related parameters were recorded on randomly selected five plants.

**Results and Discussion**

The response of germplasm lines to leaf blast reaction in UBN was presented in Table 1. Screening study revealed that, out of 35germplasm, the resistant checks (Tadukan and Tetep), shown highly resistant response, KPR-1, KPR-2, Kiruwana and IR-64 recorded resistant response, whereas, Biliya recorded moderately resistant. On contrary, Kesari, KHP-11, Hemavathi, Tunga, Jeerige sanna, Mysuru mallige, Gandasaali, Doddaabhilasha, Akkalu, MTU-1001, MO-4 and Kempu madras were shown moderate susceptibility. Puttabatta, Jyothi, JGL-1798, BPT-5204, CO-45, Amruth, Chamundi and FR-43B were shown are susceptible reaction, whereas Jaya, Intan, Ambemori, Bheemasaali, Chittiga and FR-13A were recorded highly susceptible to the leaf blast along with susceptible checks (CO-39 and HR-12).

The responses of germplasm lines to leaf blast reaction, used in screening were varied from highly resistant to highly susceptible, indicating the germplasm used in the study were diverse in nature. The significant variations for leaf blast disease in rice were also noticed by, Dar *et al.* (2015) [3], Hossain and Hegde (2016) [10], Sabin *et al.* (2016) [16], Hosagoudar *et al.* (2017) [9] and Hosagoudar *et al.* (2018) [8] under natural conditions. Whereas, Feng *et al.* (2014) [4] and Selvaraj *et al.* (2011) [17] under artificial conditions noticed significant variations for leaf blast. Hassan *et al.* (2017) [17] and Zewdu *et al.* (2017) [20] reported variations among genotypes under both natural and artificial conditions for leaf blast.

The analysis of variance revealed significant differences among the genotypes for all the studied characters (Table 2) indicating the presence of substantial amount of variability among the genotypes. The significant differences for all studied traits were also noticed by Garg *et al.* (2011) [6], Bekele *et al.* (2013) [1], Vijaykumar *et al.* (2015) [19], Chandramohan *et al.* (2016) [2], Srujana *et al.* (2017) [18].

The *per se* performance of 35 rice germplasm lines were evaluated for yield and related traits under blast hot spot region, Ponnampet is presented in Table 3. The performance of germplasm lines were compared over KPR-2 (recently released blast resistant variety)

The significant variations observed for days to 50 per cent flowering and it ranged from 100.50 to 126.50 days and for days to maturity from 135.00 to 171.00 days. The genotype Mysuru mallige (100.50 days) was earliest in flowering and the genotype Jyothi (135.00 days) was matured earliest among the germplasm lines followed by MO-4 (138.00 days). The germplasm lines Gandasaali and Chittiga recorded maximum days to 50 per cent flowering (126.50 days). The *per se* performance indicated that among germplasm lines 16 lines were earlier than KPR-2 for days to 50 per cent flowering. Whereas, maximum days of maturity were recorded for Tetep (171.00 days) and ten genotypes were found earlier in maturity over KPR-2. Significant differences for flowering were also reported by Hosagoudar *et al.* (2017) [9] and Hosagoudar *et al.* (2018) [8].

The rice germplasm lines varied in number of total tillers per plant from 4.90 to 19.68 with the mean of 12.49 and productive tillers from 4.20 to 17.86 with average of 10.97. The genotype Tunga recorded highest number of total tillers (19.68) and productive tillers per plant (17.86). Similarly, significant differences for number of tillers per plant were also reported by Hosagoudar *et al.* (2017) [9] and Hosagoudar *et al.* (2018) [8].

The plant height varied 50.64 to 114.05 cm and panicle length 11.30 to 20.68. The genotype Kiruwana (114.05 cm) was tallest and CO-39 (50.64 cm) was dwarfest followed by HR-12 (53.95 cm) and these two lines were significantly dwarfer than KPR-2. Similarly, significant differences for plant height under hot spot conditions were also reported by Hosagoudar *et al.* (2017) [9] and Hosagoudar *et al.* (2018) [8]. The genotype Tetep showed longest panicle length (20.68) followed by Puttabatta (20.40 cm). Thirteen germplasm lines recorded significantly higher panicle length than KPR-2.

The results revealed that grain yield per plant for 35 genotypes ranged between 2.50 and 22.54 g, with mean of 8.46 g. The landrace Kiruwana (22.54 g) recorded highest seed yield per plant followed by Tunga (17.15 g), whereas the check entry HR-12 (2.50 g) recorded lowest seed yield per plant and Kiruwana recorded significantly higher seed yield per plant over KPR-2. Similarly, Ramappa *et al.* (1997) [15], Hosagoudar *et al.* (2017) [9] and Hosagoudar *et al.* (2018) [8] reported significant differences for yielding ability in their genotypes under hot spot conditions. The highest test weight recorded by Jaya (35.00 g) among the germplasm lines

The wide range variation was observed in the studied germplasm lines for grain length, grain breadth and L:B ratio. The germplasm Chamundi recorded longest grain length (10.79 mm) and MO-4 (7.20 mm) recorded shorter grain length among germplasm lines studied. The genotypes, BPT-5204 reported broader grain breadth (3.47 mm) followed by FR-43B (3.24 mm). The genotype Kiruwana showed highest L:B ratio (4.06).

The genotype Kiruwana identified as leaf blast resistant line apart from Tadukan, Tetep, KPR-1, KPR-2 and IR-64, which is significantly superior for yield and yield related traits. The resistant genotypes identified through screening and *per se* performance can be used further for development of leaf blast resistant high yielding genotypes.

**Table 1:** Reaction of germplasm lines to leaf blast disease under natural epidemic conditions

| S. No. | Germplasm | Recorded scores | Description |
|---|---|---|---|
| 1 | Tadukan (C) | 1 | Highly Resistant |
| 2 | Tetep (C) | 1 | |
| 3 | KPR-1 | 2 | Resistant |
| 4 | KPR-2 | 2 | |
| 5 | Kiruwana | 2 | |
| 6 | IR-64 | 2 | |
| 7 | Biliya | 4 | Moderately resistant |
| 8 | Kesari | 5 | Moderately susceptible |
| 9 | KHP-11 | 5 | |
| 10 | Hemavathi | 5 | |
| 11 | Tunga | 5 | |
| 12 | Mysore mallige | 5 | |
| 13 | Jeerige sanna | 5 | |
| 14 | Gandasaali | 5 | |
| 15 | Doddaabhilasha | 6 | |
| 16 | Akkalu | 6 | |
| 17 | MTU-1001 | 6 | |
| 18 | MO-4 | 6 | |
| 19 | Kempu madras | 6 | |
| 20 | Puttabatta | 7 | Susceptible |
| 21 | Jyothi | 7 | |
| 22 | JGL 1798 | 7 | |
| 23 | BPT-5204 | 7 | |
| 24 | Co-45 | 7 | |
| 25 | Amruth | 7 | |
| 26 | Chamundi | 7 | |
| 27 | FR-43B | 7 | |
| 28 | Jaya | 8 | Highly susceptible |
| 29 | Intan | 8 | |
| 30 | CO-39 (C) | 9 | |
| 31 | HR-12 (C) | 9 | |
| 32 | Ambemori | 9 | |
| 33 | Bheemsali | 9 | |
| 34 | Chittiga | 9 | |
| 35 | FR-13A | 9 | |

C-checks

**Table 2:** Analysis of variance in rice germplasm lines under hot spot conditions for growth, yield and blast resistance reaction

| S. V. | d. f | Mean sums of squares | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | DFF | DM | PH (cm) | TT | PT | PL (cm) | GY (g) | GL (mm) | GB (mm) | LB ratio | TW (g) |
| Replications | 1 | 2.06 | 13.73 | 162.37 | 0.20 | 0.86 | 0.26 | 0.54 | 0.0001 | 0.01 | 0.02 | 0.04 |
| Treatments | 34 | 121.01** | 193.24** | 716.47** | 21.40** | 18.81** | 11.58** | 41.87** | 0.99** | 0.19** | 0.26** | 31.44** |
| Error | 34 | 3.50 | 3.73 | 22.24 | 2.90 | 2.12 | 2.36 | 1.70 | 0.02 | 0.02 | 0.03 | 2.87 |

DFF- Days to fifty percent flowering
DM- Days to maturity
PH-Plant height (cm)
TT- Total tillers per plant
PT- Productive tillers per plant
Pl- Panicle length (cm)
GY-grain yield per plant (g)
GL-Grain length (mm)
GB-Grain breadth (mm)
LB ratio: Length: Breadth ratio
TW- Test weight (g)

**Table 3:** *Per se* performance of rice germplasm lines for yield and its related traits under hot spot conditions of rice blast at AHRS, Ponnampet during *Kharif*-2014.

| S. No. | Germplasm lines | Days to 50% flowering | Days to maturity | Plant height (cm) | Total tillers/pl. | Productive tillers/pl. | Panicle length (cm) | Grain yield/pl. (g) | Test weight (g) | Grain length (mm) | Grain breadth (mm) | L: B ratio |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Kiruwana | 117.00 | 165.00 | 114.05 | 10.52 | 9.56 | 20.35** | 22.54** | 23.00* | 9.12** | 2.28 | 4.06** |
| 2 | Puttabatta | 120.00 | 168.50 | 110.99 | 4.90 | 4.20 | 20.40** | 11.53 | 25.00** | 9.42** | 3.07** | 3.07 |
| 3 | Biliya | 116.50 | 144.00* | 108.14 | 7.87 | 7.20 | 16.50 | 4.62 | 25.50** | 9.80** | 2.96** | 3.32 |
| 4 | Akkalu | 112.00** | 154.50 | 61.58 | 13.25 | 11.20 | 13.32 | 8.77 | 23.50** | 8.71 | 2.47 | 3.53* |
| 5 | Kesari | 124.50 | 150.50 | 55.03 | 17.64 | 15.72 | 11.30 | 6.92 | 20.50 | 9.33** | 3.00** | 3.11 |
| 6 | KHP-11 | 118.00 | 153.50 | 91.61 | 11.60 | 10.00 | 19.45* | 8.88 | 28.00** | 9.72** | 2.60 | 3.74** |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7 | Jaya | 116.50 | 154.00 | 67.42 | 18.90 | 16.80 | 16.53 | 4.55 | 35.00** | 9.46** | 3.32** | 2.85 |
| 8 | MTU-1001 | 103.50** | 139.00** | 67.68 | 9.00 | 7.90 | 15.67 | 6.01 | 27.50** | 9.27** | 3.00** | 3.09 |
| 9 | Jyothi | 102.50** | 135.00** | 71.17 | 9.85 | 8.14 | 19.11* | 10.42 | 31.70** | 9.04** | 2.85 | 3.17 |
| 10 | MO-4 | 104.00** | 138.00** | 59.15 | 12.01 | 10.08 | 15.47 | 9.75 | 30.00** | 7.20 | 2.80 | 2.57 |
| 11 | JGL -1798 | 108.00** | 143.00** | 57.24 | 15.65 | 14.53 | 17.02 | 5.50 | 16.50 | 8.81 | 2.67 | 3.31 |
| 12 | BPT 5204 | 109.00** | 146.50 | 94.28 | 8.88 | 8.46 | 16.93 | 8.17 | 19.50 | 9.88** | 3.47** | 2.85 |
| 13 | Hemavathi | 119.00 | 147.00 | 104.04 | 12.93 | 10.91 | 19.54* | 12.64 | 22.00 | 9.10** | 2.85* | 3.19 |
| 14 | Intan | 121.50 | 151.00 | 100.25 | 13.39 | 11.58 | 18.61 | 7.50 | 23.50* | 9.81** | 2.69 | 3.65** |
| 15 | Tunga | 121.00 | 168.00 | 91.84 | 19.68 | 17.86 | 19.38* | 17.15 | 25.50** | 10.41** | 3.01** | 3.46 |
| 16 | IR-64 | 106.00** | 143.50* | 59.84 | 12.18 | 11.60 | 17.00 | 13.37 | 25.50** | 9.59** | 2.40 | 4.01 |
| 17 | Ambemori | 125.00 | 151.50 | 58.56 | 10.23 | 9.17 | 15.86 | 5.50 | 21.50 | 8.96** | 3.08** | 2.92 |
| 18 | Bheemsali | 119.00 | 145.00 | 71.94 | 9.70 | 8.50 | 20.17** | 5.50 | 17.00 | 10.19** | 3.13** | 3.25 |
| 19 | Co-45 | 114.00* | 146.00 | 69.53 | 9.96 | 8.66 | 19.43* | 9.20 | 27.50** | 9.90** | 3.18** | 3.12 |
| 20 | Chamundi | 109.00** | 141.50** | 76.27 | 13.50 | 11.00 | 16.33 | 5.70 | 21.50 | 10.79** | 2.90** | 3.72** |
| 21 | FR-43B | 124.50 | 163.50 | 61.31 | 12.50 | 11.55 | 16.70 | 6.00 | 23.50* | 9.58** | 3.24** | 2.96 |
| 22 | Gandasaali | 126.50 | 160.00 | 76.64 | 12.00 | 11.70 | 19.72* | 5.50 | 24.50** | 9.48** | 2.79 | 3.40 |
| 23 | Amruth | 109.50** | 149.00 | 69.60 | 11.65 | 9.83 | 16.07 | 8.80 | 18.00 | 10.24** | 3.25** | 3.15 |
| 24 | Chittiga | 126.50 | 166.00 | 80.73 | 12.54 | 11.11 | 19.93* | 4.15 | 24.50** | 9.36** | 3.03** | 3.09 |
| 25 | Doddaabhilasha | 119.00 | 162.50 | 63.41 | 12.50 | 10.60 | 16.88 | 4.50 | 24.00** | 9.48** | 2.53 | 3.76** |
| 26 | Jeerige sanna | 114.00* | 148.50 | 103.60 | 12.53 | 9.54 | 19.89* | 3.38 | 28.00** | 9.70** | 3.14** | 3.09 |
| 27 | Kempu madras | 108.00** | 141.00** | 99.56 | 14.00 | 11.50 | 18.06 | 3.50 | 24.50** | 9.31** | 3.33** | 2.80 |
| 28 | Mysore mallige | 100.50** | 141.00** | 58.02 | 16.53 | 14.17 | 14.26 | 7.13 | 28.00** | 8.26 | 2.58 | 3.20 |
| 29 | KPR1 | 117.00 | 148.00 | 81.25 | 14.50 | 12.50 | 16.40 | 15.00 | 20.00 | 8.83** | 2.57 | 3.43 |
| 30 | KPR2 (C) | 118.00 | 148.50 | 63.95 | 18.50 | 17.20 | 15.90 | 15.90 | 19.00 | 8.25 | 2.61 | 3.17 |
| 31 | FR13A | 104.50** | 143.00** | 74.81 | 11.98 | 9.97 | 16.57 | 5.45 | 26.50** | 8.89 | 3.21** | 2.77 |
| 32 | Tadukan (C) | 122.50 | 166.00 | 96.05 | 15.00 | 13.75 | 20.09** | 13.30 | 25.50** | 9.40** | 2.99** | 3.14 |
| 33 | Tetep (C) | 121.50 | 171.00 | 99.01 | 13.45 | 12.70 | 20.68** | 12.95 | 19.50 | 9.09** | 2.60 | 3.50* |
| 34 | CO-39 (C) | 108.00** | 148.50 | 50.64* | 10.46 | 9.10 | 14.42 | 4.00 | 24.00** | 8.13 | 3.00** | 2.71 |
| 35 | HR-12 (C) | 102.00** | 146.00 | 53.95* | 7.47 | 5.60 | 12.66 | 2.50 | 22.50 | 8.51** | 2.38 | 3.60 |
| | Mean | 114.51 | 151.07 | 77.80 | 12.49 | 10.97 | 17.33 | 8.46 | 24.43 | 9.28 | 2.88 | 3.25 |
| | SEm± | 1.32 | 1.37 | 3.34 | 1.20 | 1.03 | 1.09 | 0.92 | 1.20 | 0.09 | 0.07 | 0.11 |
| | C.V. | 1.64 | 1.27 | 6.06 | 13.61 | 13.28 | 8.86 | 15.39 | 6.94 | 1.32 | 3.56 | 4.86 |
| | C.D. @ 5% | 3.80 | 3.92 | 9.58 | 3.46 | 2.96 | 3.12 | 3.56 | 3.44 | 0.25 | 0.21 | 0.32 |
| | C.D. @ 1% | 5.10 | 5.22 | 12.87 | 4.64 | 3.97 | 4.19 | 3.55 | 4.62 | 0.34 | 0.28 | 0.43 |

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