Plant Archives Vol. 25, No. 2, 2025 pp. 894-898 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org
DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2025.v25.no.2.125

PHENOTYPIC EVALUATION OF ADVANCED BREEDING LINES DERIVED FROM A MULTIPLE CROSS FOR BLAST RESISTANCE IN RICE (*ORYZA SATIVA* L.)

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(Date of Receiving-12-07-2025; Date of Acceptance-17-09-2025)

ABSTRACT

Rice is a major crop which is affected by both biotic and abiotic stresses. Among biotic stresses blast assumes utmost significance owing to its destructing ability to reduces the yields. Present study was conducted to identify the stable high yielding rice cultivars with blast resistance. A set of 30 advanced breeding lines of multiple cross [(IET 23993 × NLR 34449//BPT 5204) × (NDLR7 × Tetep //BPT 5204)]) along with checks NLR 34449, KNM 118, RNR 15048 (resistant) and TN-1, Tetep (susceptible) were screened phenotypically for blast resistance in uniform blast nursery (UBN) during *Rabi* 2023-24 at three locations 1, Institute of Rice Research (IRR), Rajendranagar, 2, RARS, Polasa, Jagityal and 3, ARS, Kampasagar of Telangana state.

Among the entries RNR 50075, RNR 50098, RNR 49922, RNR 49931 and RNR 49935 exhibited resistance reaction of '1' at RARS, Jagityal and '3' at IRR, (ARI), Hyderabad and ARS, Kampasagar. Two lines RNR 50106 and RNR 49969 have shown resistance reaction with score of '3' at three locations at RARS, Jagityal and IRR, Hyderabad and ARS, Kampasagar. Fourteen lines RNR 50020, RNR 50025, RNR 50052, RNR 50059, RNR 50060, RNR 50080, RNR 50081, RNR 50082, RNR 50099, RNR 50102, RNR 50107, RNR 50130, RNR 49956, RNR 49921 had shown moderate resistance reaction with score of '5' at three locations at RARS, Jagityal and IRR, Rajendranagar, ARS, Kampasagar.

***Key words*:** Breeding lines, biotic and abiotic stress, yield, uniform blast nursery.

Introduction

Rice (*Oryza sativa* L.) is one of the major cereal crops in the world and is the principal staple food for half of the world population and is critical, providing livelihoods for millions of farmers by cultivation especially in Asia and India. The global rice production has to be increased to 11.4% over the present-day production to meet the needs of growing population by 2030. This is impeded by the various biotic stresses and abiotic stresses. In biotic stress rice blast (*Magnaporthe oryzae* L.) is one of the major diseases that reduce the yield of the rice drastically. Managing the blast disease by using chemical methods is not environmentally friendly. The blast causes yield losses up to 70-80% (Simkhada and Thapa 2022). The choice of host plant resistance is the most effective and environmentally safe strategy to achieve increased yield potential.

The advanced 30 breeding lines obtained from the cross [(IET 23993 × NLR 34449//BPT 5204) × (NDLR7 × Tetep //BPT 5204)] were phenotypically screened for blast resistance in uniform blast nursery (UBN) in three different locations *viz*., Institute of Rice Research, ARI, Rajendranagar, RARS, Polasa, Jagityal and ARS, Kampasagar. Despite of its desirable characters, though

Table 1: Standard Evaluation System (SES) scale for leaf blast in rice (IRRI, 2013).

Scale	Disease severity	Host response
0	Lesions are not present	Highly Resistant (HR)
1	Small brown specks of pin point size or large brown specks without sporulating center	Resistant (R)
2	Small roundish to slightly elongated, necrotic gray spots, about 1-2 mm in diameter, with a distinct brown margin. Lesions are mostly found on the lower leaves	Resistant (R)
3	Lesions type is same as in scale 02, but a significant number of lesions on upper leaf area	Resistant (R)
4	Typical susceptible blast lesions, 3 mm or longer infecting less than 4% of leaf area	Moderately Resistant (MR)
5	Typical susceptible blast lesions infecting 4-10% of leaf area	Moderately Resistant (MR)
6	Typical susceptible blast lesions infecting 11-25% of the leaf area	Susceptible (S)
7	Typical susceptible blast lesions infecting 26-50% of the leaf area	Susceptible (S)
8	Typical susceptible blast lesions infecting 51-75% of the leaf area and many leaves are dead	Highly Susceptible (HS)
9	More than 75% of the leaf area affected	Highly Susceptible (HS)

having resistance to blast, there is a need to improve it for durable resistance. *Pi54* and *Pi1* is the highly resistant gene that showed broad spectrum resistance against predominant races found in India (Ramkumar *et al*., 2011). Hence, the present study was undertaken to develop breeding lines with durable resistance to blast (*Pi54* & *Pi1*) along with high yield.

Material and Methods

The experimental material comprised of 30 breeding lines developed by advancement of F_5- F_6 generation of multiple cross [(IET 23993 × NLR 34449 // BPT 5204) × (NDLR 7 × Tetep // BPT 5204)] for the phenotypic screening for blast disease.

NLR 34449, KNM 118, RNR 15048 (resistant) and TN-1, Tetep (susceptible) were used as checks while screening for blast disease in Uniform blast nursery. The research work was carried out at Institute of Rice Research (IRR), ARI, Rajendranagar, RARS, Polasa, Jagtial and ARS, Kampasagar.

Screening of advanced breeding lines in Uniform Blast Nursery

A total number of 30 advanced breeding lines developed from a multiple cross [(IET 23993 × NLR 34449 // BPT 5204) × (NDLR 7 × Tetep // BPT 5204)] along with checks were screened for blast resistance under in-vivo conditions in Uniform blast nursery (UBN) at Institute of Rice Research, ARI, Rajendranagar, Regional Agriculture Research Station (RARS), Polasa, Jagtial, ARS, Kampasagar, Telangana during *rabi* 2023-2024 (Fig. 1).

Solid rows of breeding lines and checks, 50cm each surrounded by susceptible check on all sides was planted and at every 10th row a susceptible check was used. A local isolate Pg 4 and pg 2 of *Magnoporthe grisea* collected and maintained according to the procedure of Srinivas Prasad *et al*., (2011) was used for screening the selected advanced breeding lines. The young seedlings at four-leaf stage were inoculated with the fungal conidial suspension at concentration of 1×10^5 conidia/ml and inoculated seedlings were monitored for the development of blast lesions and fifteen days after inoculation the breeding lines were scored based on the leaf blast severity as per Standard Evaluation System (SES) scale of the International Rice Research Institute (IRRI), Philippines (IRRI, 2013).

Results and Discussion

All the 30 breeding lines exhibited resistant to moderate resistant and susceptible reaction with disease scores ranged from "1" to "9" in three locations. Among the 30 breeding lines screened, five breeding lines *viz*., RNR 50075, RNR 50098, RNR 49922, RNR 49931 and RNR 49935 recorded resistance reaction with score of '1' at RARS, Jagtial and '3' at IRR, (ARI), Hyderabad and ARS, Kampasagar. Two breeding lines RNR 50106 and RNR 49969 have shown resistance reaction with a score of '3' at three locations at RARS, Jagtial and IRR, Hyderabad and ARS, Kampasagar. Fourteen breeding lines RNR 50020, RNR 50025, RNR 50052, RNR 50059, RNR 50060, RNR 50080, RNR 50081, RNR 50082, RNR 50099, RNR 50102, RNR 50107, RNR 50130, RNR 49956 and RNR 49921 have shown moderate resistance reaction with score of '5' at three locations at RARS, Jagityal and IRR, Rajendranagar, ARS, Kampasagar.

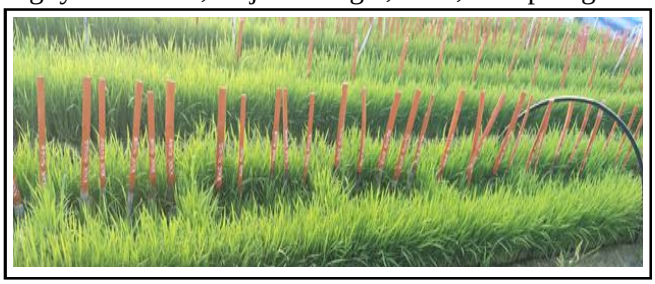

Fig. 1: Phenotypic screening of advanced breeding lines (F6 Generation) for blast in Uniform Blast Nursery (UBN) during Rabi 2023-24 at IRR, Rajendranagar.

T**able 2:** Blast reaction of 30 genotypes based on 0-9 scale (IRRI- SES, 2013) in rice at different environments.

S. No.	Advanced breeding lines	Reaction against blast screening at IRR (ARI), Rajendranagar		Reaction against blast screening at ARS Kampasagar		Reaction against blast screening at RARS Jagityal	
		Score	Disease Reaction	Score	Disease Reaction	Score	Disease Reaction
1	RNR 50015	7.2	HS	7.6	HS	7.4	HS
2	RNR 50020	5	MR	5	MR	5	MR
3	RNR 50025	5	MR	5	MR	5	MR
4	RNR 50035	7	S	6	S	6	S
5	RNR 50036	7.4	HS	7.4	HS	7.6	HS
6	RNR 50052	5	MR	5	MR	5	MR
7	RNR 50059	5	MR	5	MR	5	MR
8	RNR 50060	5	MR	5	MR	5	MR
9	RNR 50063	7	S	6	S	6	S
10	RNR 50075	1	R	3	R	3	R
11	RNR 50080	5	MR	5	MR	5	MR
12	RNR 50081	5	MR	5	MR	5	MR
13	RNR 50082	5	MR	5	MR	5	MR
14	RNR 50085	7	S	6	S	6	S
15	RNR 50086	7	S	7	S	7	S
16	RNR 50098	1	R	3	R	3	R
17	RNR 50099	5	MR	5	MR	5	MR
18	RNR 50102	5	MR	5	MR	5	MR
19	RNR 50106	3	R	3	R	3	R
20	RNR 50107	5	MR	5	MR	5	MR
21	RNR 50130	5	MR	5	MR	5	MR
22	RNR 49956	5	MR	5	MR	5	MR
23	RNR 49962	7	S	7	S	7	S
24	RNR 49978	7	S	7	S	7	S
25	RNR 49920	7	S	7	S	7	S
26	RNR 49921	5	MR	5	MR	5	MR
27	RNR 49922	1	R	3	R	3	R
28	RNR 49931	1	R	3	R	3	R
29	RNR 49935	1	R	3	R	3	R
30	RNR 49969	3	R	3	R	3	R
Resistant check	NLR 34449	1	R	3	R	3	R
Resistant check	KNM 118	3	R	3	R	3	R
Resistant Check	RNR 15048	3	R	3	R	3	R
Susceptible Check	TN-1	9	HS	9	HS	9	HS
Susceptible Check	Tetep	9	HS	9	HS	9	HS

Eight breeding lines RNR 50015, RNR 50035, RNR 50036, RNR 50063, RNR 50085, RNR 50086, RNR 49962, RNR 49978 and RNR 49920 have shown susceptible reaction with score of '7' at IRR, Rajendranagar and five breeding lines RNR 50015, RNR 50035, RNR 50036, RNR 50063 and RNR 50085 have shown susceptible reaction with score of '6' at RARS and ARS, Kampasagar. Two breeding lines RNR 50015 and RNR 50036 have shown highly susceptible reaction with scores 7.2, 7.6, 7.4 in all three locations. RNR 15048 and KNM 118 were found to be resistant to blast disease with disease score of 3 was susceptible with score of 7 and susceptible check TN1 and CO-39 was highly susceptible with disease score of 9 and resistant check NLR 34449 was highly resistant with disease score of 1 at IRR, Rajendranagar and score 3 at RARS, Jagityal and ARS, Kampasagar. Similar results were reported by Srijan *et al.,* (2015) and Umamahesh *et al.,* (2024)

The high blast incidence in susceptible check indicates the sufficient disease pressure created for successful

Table 3: Rice genotypes showing disease reaction.

Disease reaction	Genotypes	Total number
Resistance	RNR 50075, RNR 50098, RNR 50106, RNR 49922, RNR 49931, RNR 49935, RNR 49969	7
Moderately Resistance	RNR 50020, RNR 50025, RNR 50052, RNR 50059, RNR 50060, RNR 50080, RNR 50081, RNR 50082, RNR 50099, RNR 50102, RNR 50107, RNR 50130, RNR 49956, RNR 49921	14
susceptible	RNR 50035, RNR 50063, RNR 50085, RNR 50086, RNR 49962, RNR 49978, RNR 49920	7
Highly susceptible	RNR 50015, RNR 50036	2

screening under uniform blast nursery. Difference in the disease reaction might be attributed to more disease severity at three different locations in that particular season and due to differences in the blast pathogen races at RARS, Polasa, Jagityal and IRR, ARI, Rajendranagar, Hyderabad and ARS, Kampasagar. Similar results were reported by Aravind *et al*., (2020) and Acharya *et al*., (2019) stating that isolates of *M. oryzae* from various locations of Telangana State consists of variable pathogen populations based on cultural, morphological characteristics and virulence diversity. Similar results were observed by Jamaloddin *et al*., (2020), Arooj *et al*., (2022) and Arivin *et al*., (2025) as they tested blast resistance introgressed lines under different locations and concluded that the resistance reaction would vary due to the variation in the pathogen population at different locations across.

In the present study, the breeding lines possessing blast resistance gene (*Pi54* & *pi1*) are expected to show high level of resistance against blast disease in Telangana and other South Indian States, as the two genes are known to be effective with broad spectrum resistance in these locations (Aruna kumari *et al*., 2016), Balachiranjeevi *et al*., (2015), Laxmi Prasanna *et al*., (2018) Krishna *et al*., (2020) and Sadhana *et al*., (2023).

Conclusion

The present study aimed to identify the sources of blast resistance from the stabilized breeding lines developed from a multiple cross. Among the 30 breeding lines evaluated RNR 50075, RNR 50098, RNR 50106, RNR 49922, RNR 49931, RNR 49935, RNR 49969 exhibited a resistant reaction to blast disease under the uniform blast nursery conditions at the Institute of Rice Research, ARI, Rajendranagar, RARS, Polasa, Jagityal, ARS, Kampasagar The lines identified with blast resistance will definitely aid the crop improvement group of rice by providing sources with enhanced genetic base and diversified gene constellations hence offering a durable resistance.

Acknowledgement

The Author expresses sincere gratitude to Head of the Department, College of Agriculture, Rajendranagar, PJTAU, Hyderabad and to Institute of Rice Research, ARI, Hyderabad as well as to the Scientists and Professors for their constant support and guidance in conducting the experiment.

Competing Interests: None

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