PHENOTYPIC SCREENING OF ADVANCED BREEDING LINES FOR BLAST RESISTANCE IN RICE (*Oryza sativa* L.)

ABSTRACT

Rice is predominantly grown in Asia, which accounts for about 90% of global production. Rice crop is affected by both biotic and abiotic stresses, biotic stresses such as blast, bacterial blight which significantly reduces the yields. Present study was conducted to introgress the blast gene *Pi54* into the genetic background of the rice variety Telangana Sona (RNR 15048) through marker assisted pedigree breeding. A cross was made between Telangana Sona (RNR 15048) and near isogenic line of cottondorasannalu (MTU1010NIL). A set of 40 advanced breeding lines (F_5) were screened phenotypically for blast resistance in uniform blast nursery (UBN) during*Rabi* 2023-24 at RARS, Polasa, Jagtial. Among the 40 breeding lines screened for blast, 12 breeding lines were shown resistant reaction with a disease score of 1, 18 breeding lines exhibited resistant reaction with a disease score of 3 and 10 breeding lines were exhibited moderate resistant reactionwith disease score of 5. These thirty breeding lines exhibited resistance reaction to blast with durable resistance, could serve as good donors for blast and further forwarded to conduct multi location trials and further to release as new varieties through AICRP.

Key words:*Introgress, MTU1010NIL, Marker assisted pedigree breeding, uniform blast nursery*.

1. 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. The global rice production would have to increase 11.4% over the present-day production to meet growing population by 2030. This is impeded by the various biotic stresses and abiotic stresses. In biotic stressrice blast (*Pyricularia 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. Economically, rice is critical, providing livelihoods for millions of farmers by cultivation especially in Asia and India. The blast causes yield losses upto 70-80%Simkhada and Thapa(2).The choice of host plant resistance is the most effective and environmentally safe strategy to achieve increased yield potential. Marker assisted breeding is a very effective strategy to develop durable and broad-spectrum resistant rice cultivars.

Telangana Sona (RNR 15048)(IET23746) is an elite variety developed from the cross between MTU1010 and JGL 3855 in 2015 by Institute of Rice Research (IRR), Agricultural Research Institute (ARI), Professor Jayashankar Telangana State Agricultural University (PJTSAU), Rajendranagar. It is high yielding variety with short duration (125 days) possessing desirable short slender grain type with low glycemic index (51.72) and good cooking quality.Despite of its desirable characters, though having resistance to blast, these is a need to improve it for durable resistance. *Pi54* 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 similar to RNR 15048 (Telangana Sona) with durable resistance to blast (*Pi54*) through marker assisted selection, along with high yield, similar grain type (short slender) and good cooking quality.

2. MATERIAL & METHODS

2.1Plant material:ICAR-IIRR in collaboration with IRRI, developed NILs of MTU1010 (IR121055-2-10-7) having long slender grain type and possessing blast gene *Pi54*. TN1and NLR 34449 are the susceptible and resistant checks respectively used while screening for blast disease in Uniform blast nursery. A total number of 40 advanced breeding lines developed using the abovementioned cross were selected for the phenotypic screening for blast disease in the present study. Telangana Sona (RNR 15048) an elite high yielding variety with short duration (125 days), low glycemic index (51.72) and good cooking quality is used as female parent to develop the breeding lines (F_5 generation), while MTU1010NIL is used as a male parent. The research work is carried out at Regional Agricultural Research Station, RARS, Jagtial.

2.1 screening of advanced breeding lines in Uniform Blast Nursery

A total number of 40 advanced breeding lines developed by cross between RNR 15048 x MTU1010NIL,along with the parents and checkswere screened for blast resistance under *in-vivo* conditions in Uniform blast nursery (UBN) at Regional Agriculture Research Station (RARS), Polasa, Jagtial, Telangana during *Rabi* 2023-2024(Figure: 1). Solid row of breeding lines, parents and checks, 50cm each surrounded by susceptible check on all sides was planted and at every 10^{th} row a susceptible check was used.A local isolate Pg 4 of *Magnoporthegrisea* collected and maintained according to the procedureof Srinivas Prasad*et al*. (2) was used for screening the selected advanced breeding lines, NLR 34449 was used as resistant check and TN1 was used as susceptible check. The young seedlings at four-leaf stage were inoculated with the fungal conidial suspension at a concentration of $1x10^5$ 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).

3. RESULTS

All the 40 advanced breeding lines and parents screened using blast cultures(pg 4) exhibited resistant to moderate resistant reaction with disease scores ranged from “1” to “5”. Among 40 advanced breeding lines screened, 12 breeding lines *viz*., PUM-2, PUM-3, PUM-5, PUM-6, PUM-9, PUM-15, PUM-17, PUM-18, PUM-23, PUM-28, PUM-30 and PUM-37 were shown resistance reaction with disease score of ‘1’. 18 breeding lines *viz*., PUM-1, PUM-7, PUM-8, PUM-10, PUM-11, PUM-14, PUM-20, PUM-21, PUM-24, PUM-27, PUM-29, PUM-31, PUM-32 PUM-33, PUM-34, PUM-35, PUM-36 and PUM-38 have shown resistance reaction with disease score of ‘3’. 10 breeding lines PUM-4, PUM-12, PUM-13, PUM-16, PUM-19, PUM-22, PUM-25 and PUM-26, PUM-39 and PUM-40, have shown moderate resistance reaction with score of ‘5’and RNR 15048 have shown resistance reaction with disease score of ‘3’ and MTU1010NIL wasshown resistance reaction with disease score of

3.Susceptible check TN1 was shown susceptible reaction with disease score of '7' while, resistant check NLR 34449 was shownresistancereaction with disease score of '1'(table 1)The high incidence of blast in the susceptible check indicates sufficient disease pressure for effective screening in the uniform blast nursery.

Table.1: Results of Phenotypic screening of advanced breeding lines (F_5 Generation) for blast in Uniform Blast Nursery (UBN) during *Rabi* 2023-24 at RARS, Jagtial.

S. No	Parents and improved lines	Reaction against blast screening at RARS, Jagtial	
		Score	Disease Reaction
1	PUM-1	3	R
2	PUM-2	1	R
3	PUM-3	1	R
4	PUM-4	5	MR
5	PUM-5	1	R
6	PUM-6	1	R
7	PUM-7	3	R
8	PUM-8	3	R
9	PUM-9	1	R
10	PUM-10	3	R
11	PUM-11	3	R
12	PUM-12	5	MR
13	PUM-13	5	MR
14	PUM-14	3	R
15	PUM-15	1	R
16	PUM-16	5	MR
17	PUM-17	1	R
18	PUM-18	1	R
19	PUM-19	5	MR
20	PUM-20	3	R
21	PUM-21	3	R
22	PUM-22	5	MR
23	PUM-23	1	R
24	PUM-24	3	R
25	PUM-25	5	MR
26	PUM-26	5	MR
27	PUM-27	3	R
28	PUM-28	1	R
29	PUM-29	3	R
30	PUM-30	1	R
31	PUM-31	3	R
32	PUM-32	3	R
33	PUM-33	3	R
34	PUM-34	3	R
35	PUM-35	3	R
36	PUM-36	3	R
37	PUM-37	1	R
38	PUM-38	3	R

39	PUM-39	5	MR
40	PUM-40	5	MR
Parent 1	RNR15048	3	R
Parent 2	MTU1010NIL	3	R
Resistant check	NLR 34449	1	R
Susceptible check	TN1	7	S

Figure: 1: Phenotypic screening of advanced breeding lines (F_5 Generation) for blast in Uniform Blast Nursery (UBN) during *Rabi* 2023-24 at RARS, Jagtial.

4. DISCUSSIONS

To prevent the breakdown of resistance conferred by a single gene, it is desirable to combine two or more genes in the genetic background of elite cultivars Sundaram *et al.* (3). However, there have been various reports indicating that a single major blast resistance gene, such as *Pi54*, has provided the desired level of resistance against the disease Balachiranjeevi*et al*. (4), Laxmi Prasanna *et al*. (5) and Sadhana *et al*. (6).

5. CONCLUSION

In this study, we transferred one major dominant resistance gene for blast (*Pi54*) through marker-assisted pedigree breeding using RNR 15048 as female parent. The resulting breeding lines, which possess *Pi54* gene, were exhibitedgood level of resistance against blast disease at station level and expecting to perform same in different locations of Telangana and other South Indian states, as the lines with *Pi54* gene showed broad spectrum resistance against predominant races found in India. The developed breeding lines in the present study are similar to RNR 15048 (Telangana Sona) with durable resistance to blast (*Pi54*) along with high yield and similar grain type (short slender) with good cooking quality.

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References

1. Simkhada, K. and Thapa, R. 2022. Rice blast, a major threat to the rice production andits various management techniques. *Turkish Journal of Agriculture-Food Science and Technology*. 10(2): 147-157.
2. Srinivas Prasad, M., Shesu Madhav, M., Laha, G.S., Ladha Lakshmi, D., Krishnaveni, D., Mangrauthia, S.K., Balachandran, S.M., Sundaram, R.M., Arunakanthi, B., Madhan Mohan, K., Ratna Madhavi, K., Kumar, V and Virakatamath, B.C. 2011. Rice blast disease and its management. Directorate of Rice Research (ICAR), Hyderabad.
3. Sundaram, R. M., Vishnupriya, M. R., Biradar, S. K., Laha, G. S., Reddy, G. A., Rani, N. S and Sonti, R. V. 2008. Marker assisted introgression of bacterial blight resistance in Samba Mahsuri, an elite *indica* rice variety. *Euphytica*. 160 (3): 411-422.
4. Balachiranjeevi, C.H., Bhaskar, N.S., Abhilash, V., Akanksha, S., Viraktamath, B.C., Madhav, M.S., Hariprasad, A.S., Laha, G.S., Prasad, M.S., Balachandran, S.M and Neeraja, C.N. 2015. Marker-assisted introgression of bacterial blight and blast resistance into DRR17B, an elite, fine-grain type maintainer line of rice. *Molecular Breeding*. 35: 1-12.
5. Laxmi Prasanna, B., Dangi, K.S., Raju, C.D., Jagadeeshwar, R and Sundaram, R.M. 2018. Phenotypic screening of the breeding lines of MTU 1010 derived through marker-assisted pedigree breeding for resistance against bacterial blight and blast. *Journal of Research PJTSAU*. 46 (2/3): 41-46.
6. Sadhana, P., Rao, P., Prasanna, B.L., Babu, T.K., Sundaram, R.M. and Balram,N. 2023.Identification of Blast Resistant Breeding Lines through Uniform Blast Nursery in Rice (Oryza sativa L.). *International Journal of Environment and Climate Change*. 13(9): 1059-1065.

7. Ramkumar, G., Srinivasa Rao, K., Madhan Mohan, K., Sudarshan, I., Sivaranjani, A.K.P., Gopala Krishna, K., Neeraja, C.N., Balachandran, S.M., Sundaram, R.M., Prasad, M.S., Shobha Rani, N., Ram Prasad, A.M., Virakmath, B.C and Madhav, M.S. 2011. Development and validation of functional marker targeting an In Del in the major rice blast disease resistance gene *Pi54* (*Pikh*). *Molecular Breeding*. 27: 129-135.
8. Thulasinathan T, Ayyenar B, Kambale R, Manickam S, Chellappan G, Shanmugavel P, Narayanan MB, Swaminathan M, Muthurajan R. Marker assisted introgression of resistance genes and phenotypic evaluation enabled identification of durable and broad-spectrum blast resistance in elite rice cultivar, CO 51. Genes. 2023 Mar 15;14(3):719.
9. Singh AK, Ponnuswamy R, Srinivas Prasad M, Sundaram RM, Hari Prasad AS, Senguttuvel P, Kempa Raju KB, Sruthi K. Improving blast resistance of maintainer line DRR 9B by transferring broad spectrum resistance gene Pi2 by marker assisted selection in rice. Physiology and Molecular Biology of Plants. 2023 Feb;29(2):253-62.
10. Soujanya T, Madamsetty SP, Hemalatha V, KN Y, Bandela E, AS HP, Raman MS, Ponnuswamy R. Improving hybrid rice parental lines for blast resistance by introgression of broad-spectrum resistance genes Pi54 and Pi9 by marker-assisted selection. Plant Breeding. 2023 Jun;142(3):300-11.
11. Raj R, Kumar A, Touthang L, Das SP, Rai M, Verma VK, Mishra VK. Revealing the Novel Genetic Resources for Blast Resistance in Diverse Rice Landraces of North-Eastern Hills of Himalayas. Plant Molecular Biology Reporter. 2024 Apr 20:1-7.