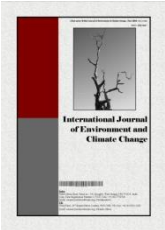

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Phenotypic Screening of F_4 Breeding Lines against Bacterial Blight Disease in Rice

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Biotic stresses are major threat to rice production. Among biotic stresses, bacterial leaf blight is one of the major diseases affecting rice grain production in rice growing areas. Present investigation was conducted to evaluate phenotypic effect of 50 breeding lines from a cross (Pranahitha//ISM/MTU1010) in glass house at Regional Agricultural Research Station, Jagtial by inoculating Bacterial leaf blight culture (DX-020) by leaf clipping method. Out of these 50 F_4 lines evaluated, twenty nine breeding lines showed resistant reaction with disease score of 1. Eleven lines showed moderately resistant reaction with disease score 3. Twenty nine breeding lines that were resistant with disease score 1, had excellent grain yield. Hence, these lines can be advanced to further generations. Thus the present study has demonstrated that phenotypic selection is successful in the glass house and these breeding lines with higher yield levels are expected to perform better in the field trials and further in the farmers fields with the good level of bacterial blight resistance.

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Keywords: Rice; bacterial blight; leaf clipping method and phenotypic screening.

1. INTRODUCTION

Rice is one of the major food crops of the world and forms the staple diet of about half of the world's population. Approximately 90.4% of the world's rice is grown in the Asian continent. It constitutes a staple food crop (up to 60% of energy intake) for 2.7 billion people worldwide [1]. The demand for rice is boosting up further in the view of expected increase in population. Biotic and abiotic stresses are major constraints for rigorous yield loss affecting rice production. Among biotic stresses, bacteria leaf blight (BB) is one of the serious disease caused by the pathogen *Xanthomonas oryzae pv. oryzae (Xoo)* which is responsible for significant yield reduction in rice. Bacterial blight causes yield loss of about 50 % [2] and in severally infected field, losses could rise to about 59-90% and even 100% under very severe conditions [3,4]. It was first reported in India in 1951 [5,6] and has been commonly occurring since the introduction of the semi-dwarf high yielding varieties (HYV) of rice from the Philippines during mid-1960's. It was found that the increased application of nitrogenous fertilizer enhances disease development in these rice varieties. Several tested chemicals or antibiotics have proven not totally effective in the control the BB infestation completely. Bacterial blight reduces rice yield by declining the crop photosynthetic area [7]. Persistent, injudicious use of chemicals has toxic effects on non-target organisms and causes undesirable changes to environment. Most of these chemicals available are too expensive for the resource poor farmers of Asia, where 90% of the world's rice is grown. Consequently, most effective, sustainable and environment friendly approach is development and deployment of BB resistant rice varieties introgressed with resistant genes. In this process, phenotypic screening of bacterial blight disease would be of great use for evaluation of breeding lines. This work is carried out to evaluate bacterial blight resistance at phenotypic level.

2. MATERIALS AND METHODS

The material of present study includes 50 genotypes derived from a three way cross (Pranahitha//ISM/MTU1010 NIL).

Table. 1. The plant material includes three rice varieties *viz*., Pranahitha (JGL11727), ISM and MTU1010 NIL which are used as parents of a three way cross Pranahitha//ISM/ MTU1010 NIL

Genotype	Breeding method	Special features
Pranahitha (JGL11727)	Developed through Pedigree method	It is a fine grain rice variety with good cooking quality and suitable for irrigated conditions. It is released through State varietal release committee (SVRC) during the year 2012 from Regional Agricultural Research Station (RARS), Polasa, Jagtial.
Improved Samba Mahsuri (ISM)	Developed through marker assisted backcross breeding	It is a medium duration variety. Three genes pyramided line (*Xa21*, *xa13* and *xa5*), exhibits high level of resistance to BB disease, shows high yield advantage over Samba Mahsuri. It is released during year 2008 from Indian Institute of Rice Research (ICAR-IIRR), Hyderabad
MTU1010 NIL	Developed through marker assisted backcross breeding (MABB)	MTU1010 is a short duration semi dwarf Mega variety (120-125 days) with long slender grain type, resistant to blast but susceptible to BB. MTU1010 is introgressed with *Gn1a* gene through marker assisted back cross breeding by International Rice Research Instistute(IRRI), Philippines & Indian Institute of Rice Research (ICAR- IIRR), Hyderabad and MTU1010 NIL possessing *Gn1a* was developed.

Table. 2. Standard evaluation system, IRRI scale (2013) for bacterial leaf blight

Scale	Rating	% leaf area diseased
1	Highly resistant	1-5
3	Resistant	6-12
5	Moderately resistant	13-25
7	Susceptible	26-50
9	Highly susceptible	51-100

The experiment was carried out in glass house at Regional Agricultural Research Station, (RARS), Polasa, Jagtial during *Rabi* 2020-21, where the artificial inoculation was done. The research station is located at Northern Telangana zone, Telangana, India. Experimental plots was laid out in Randomised Block Design (RBD) with two replications for the evaluation of yield and other agromorphological parameters.

2.1 Bacterial Leaf Blight Screening and Evaluation

The selected target F_4 plants along with the parents were screened in the glass house at RARS, Jagtial. The bacterial cultures of virulent isolate, DX- 020 of *Xanthomonas oryzae* pv. *oryzae* (collected from IIRR, Hyderabad, Telangana) were maintained on Hayward's agar media at 28^0C for 96 hours. After incubation period, the bacterial cells were harvested and diluted with 10ml of sterile distilled water to get a final concentration of approximately10^8cfu/ml [8]. Homozygous F_4 lines were inoculated with bacterial culture at maximum tillering and flag leaf stages by following leaf clipping method described by Kauffman et al. [9]. Plant inoculation was carried out by clipping the tip (about 1 to 2 cm) of the fully expanded uppermost leaf with scissors that had been dipped into the inoculum. The lesion length on leaves was measured at 15 days after inoculation. Scoring was done using Standard Evaluation System (SES), International Rice Research Institute (IRRI) scale, 2013.

The disease was scored on 1 to 9 scales using IRRI Standard evaluation system given Table 2.

3. RESULTS AND DISCUSSION

3.1 Phenotypic Evaluation of Improved Breeding Lines for BB

Bacterial leaf blight is one of the major diseases especially in the rice growing areas, which affects the rice grain production. To overcome this problem, a study was conducted to develop a high yielding line possessing BB resistance using Pranahitha, a popular variety in the state of Telangana with good cooking quality. In the present study, 50 breeding lines (F_4 generation) obtained from a cross (Pranahitha//ISM/MTU1010) were evaluated phenotypically in the glass house for Bacterial blight resistance. From Table 3, out of the 50 F_4 breeding lines evaluated against BB, twenty nine breeding lines (KAL1, KAL-2, KAL-3, KAL-4, KAL-5, KAL-6, KAL-7, KAL-8, KAL-9, KAL-11, KAL-18, KAL-19, KAL-21, KAL-22, KAL-23, KAL-24, KAL-25, KAL-26, KAL-27, KAL-28, KAL-29, KAL-31, KAL-32, KAL-33, KAL-34, KAL-42, KAL-43, KAL-45, KAL-46) showed resistant reaction with disease score of 3. Ten lines of KAL-10, KAL-12, KAL-14, KAL-17, KAL-20, KAL-30, KAL-36, KAL-47, KAL-48 and KAL-49 shown moderately resistant with disease score of 5. Seven breeding lines of KAL-15, KAL-16, KAL-35, KAL-37, KAL-38, KAL-41 and KAL-44 were susceptible and remaining four lines (KAL-13, KAL-39, KAL-40, KAL-50) were highly susceptible. There are many studies shown excellent resistance of cultivars using gene pyramiding with two or more genes [10], single gene like *Xa21* conferring durable resistance against BB [11-13] were shown good level of resistance to known races.

Table 3. Screening details of Improved F_4 breeding lines for BB resistance and scoring details using IRRI-SES (Standard Evaluation System) scale (IRRI 2013)

S. No.	Improved breeding lines (F_4)	Reaction against BB	
		DX020	
		Score	HR/R/MR/S/HS
1	KAL1	3	R
2	KAL 2	3	R

S. No.	Improved breeding lines (F_4)	Reaction against BB	
		DX020	
		Score	HR/R/MR/S/HS
3	KAL 3	3	R
4	KAL 4	3	R
5	KAL 5	3	R
6	KAL 6	3	R
7	KAL 7	3	R
8	KAL 8	3	R
9	KAL 9	3	R
10	KAL 10	5	MR
11	KAL 11	3	R
12	KAL 12	5	MR
13	KAL 13	9	HS
14	KAL 14	5	MR
15	KAL 15	7	S
16	KAL 16	7	S
17	KAL 17	5	MR
18	KAL 18	3	R
19	KAL 19	3	R
20	KAL 20	5	MR
21	KAL 21	3	R
22	KAL22	3	R
23	KAL 23	3	R
24	KAL 24	3	R
25	KAL 25	3	R
26	KAL 26	3	R
27	KAL 27	3	R
28	KAL 28	3	R
29	KAL 29	3	R
30	KAL 30	5	MR
31	KAL 31	3	R
32	KAL 32	3	R
33	KAL 33	3	R
34	KAL 34	3	R
35	KAL 35	7	S
36	KAL 36	5	MR
37	KAL 37	7	S
38	KAL 38	7	S
39	KAL 39	9	HS
40	KAL 40	9	HS
41	KAL 41	7	S
42	KAL 42	3	R
43	KAL 43	3	R
44	KAL 44	7	S
45	KAL 45	3	R
46	KAL 46	3	R
47	KAL 47	5	MR
48	KAL 48	5	MR
49	KAL 49	5	MR
50	KAL 50	9	HS

Fig.1. Phenotypic screening for bacterial blight resistance using *Xoo* (DX020) culture. (As indicated in the figure ISM (Improved Samba Mashuri) is used as Resistant check; MTU1010 is used as susceptible check and KAL-1, KAL-2 and KAL-3 are Improved breeding lines in F_4 Generation possessing *Xa21 and Gn1a*, showing resistant reaction

4. CONCLUSION

Superior breeding lines developed in the present study (Resistant and moderately resistant lines) will be advanced through pedigree method of breeding for possible multiplication and could be evaluated through multilocation trials in the state of Telangana and also across the country through All Indian Coordinated Research Improvement Project (AICRIP). After the evaluation of these breeding lines in the field condition, then can be evaluated through the above mentioned trials and the best one can be released as a variety to serve the purpose of farmer's need in the state. Also these breeding lines possessing bacterial leaf blight (BB) resistance along with good yield levels can serve as good donors for targeted transfer of the major gene to other elite rice varieties cultivated in Telangana state.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Salim M, Akram M, Akhtar ME, Ashraf M. A production handbook, balanced fertilization for maximizing economic crop yields, Pakistan Research Council, Islamabad. 2003;1-8.
2. Ou SH. Common wealth Mycological Institute. Rice diseases. Kew; 1985.
3. Agarwal PK, Sidu GS, Gosal SS. Induction of bacterial blight resistance in elite Indian rice (*Oryza sativa* L.) cultivars using gamma irradiation and ethyl methane sulfonate. Mutation Breeding Newsletter and Reviews. 2005;1:17-18.
4. Singh AK, Sarma BK, Singh PK, Nandan R. Screening of rice (*Oryza sativa* L.) germplasms against *Xanthomonas oryzae* pv. *oryzae*. Journal of Eco-friendly Agriculture. 2013;8(1):86-88.
5. Srinivasan MC, Thirumulachar MJ, Patel MK. Bacterial blight of rice. Current Science. 1959;28:469-470.
6. Bhapkar DG, Kulkarni NB, Chavan VM. Bacterial blight of paddy. Poona Agricultural College Magazine. 1960;51:36-46.
7. Pradhan SK, Nayak DK, Mohanty S, Behera L, Barik SR, Pandit E, Lenka S, Anandan A. Pyramiding of three bacterial blight resistance genes for broad-spectrum resistance in deep water rice variety, Jalmagna. Rice. 2015;8:19.
8. Preece TF, Rhodes ME, Skinner FA. Progression of bacterial disease within

plants. Bacterial and plants, eds Academic Press, London. 1982;71-83.
9. Kauffman HE, Reddy APK, Hsieh SPY, Merca SD. An improved technique for evaluating resistance of rice varieties to *Xanthomonas oryzae*. Plant Disease Reports. 1973;57(6):537-541.
10. Sundaram RM, Vishnu Priya MR, Sunil KB, Gouri SL, Ashok Reddy G, Shobha Rani, Sharma PN, Ramesh VS. Marker assisted introgression of bacterial blight resistance in Sambha Mahsuri, an elite *Indica* rice variety. Euphytica. 2008;160(3):411-422.
11. Balachiranjeevi CH, Naik BS, Kumar AV, Harika G, Swamy MHK, Hajira SK, et al. Marker- assisted pyramiding of broad-spectrum bacterial blight resistance genes into an elite maintainer line. Plos One. 2018;13(10):0201271.
12. Arunakumari K, Durgarani CV, Satturi V, Sarikonda KR, Chittoor PDR, Vutukuri B, et al. Marker assisted pyramiding of genes conferring resistance against bacterial blight and blast diseases into Indian rice variety MTU1010. Rice Science. 2016;23(6):306-316.
13. Laxmi Prasanna B, Dangi KS, Sundaram RM, Damodar Raju CH, Jagadeeshwar R, Rekha G, Sinha P. Screening of breeding lines of MTU1010 for their resistance against bacterial blight and blast. International Journal of Current Microbiology and Applied Sciences. 2018;7(7):4077-4084.

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