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Screening of Rice Germplasm against Multiple Diseases and their Yield Performance

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A B S T R A C T

A large rice germplasm accessions was evaluated for resistance against major three diseases, *viz*., bacterial leaf blight (*Xanthomonas oryzae* pv. *oryzae*), sheath blight (*Rhizoctonia solani*) and sheath rot (*Soracladium oryzae*) in two successive generation i.e. *Kharif* 2017 and *Kharif* 2018 along with six checks. All the genotypes were evaluated under artificial field inoculation. On the basis of disease intensity, none of the entries were found immune or resistant for all the three major diseases for both the years. However, eleven genotypes viz., Ayepyaung, Umari, R 1882-306-4-243-1, Dubraj-11, Jaya, YNP 7066, CR 3856-29-14-2-1-1-7-1, CR 3504-12-2-1-1-1-1, Madhuraj-55, Barhasaal and Krishnanjana; three genotypes namely, Umari, R 2053-202-2-145-1 and IC : 124525 and only two genotypes Kamini Joha and Loktimachhi were showed moderately resistant reaction for bacterial leaf blight, sheath blight and sheath rot, respectively. Low severity for both bacterial leaf blight and sheath rot were found in Umari, CR 3856-29-14-2-1-1-7-1 and R 2053-202-1245-1.The genotypes CR 3504-12-2-1-1-1-1 moderately resistant for BLB, IC : 124525 moderately resistant for sheath blight and Loktimachhi moderately resistant for sheath rot were found to be significantly superior for yield per plant. These genotypes can be further exploit for the development of high yielding resistant varieties.

Introduction

Rice serve as a pillar for providing global food security as it is the major cereal crop for more than half of the world's human population. The biotic and abiotic stresses causing severe yield losses that significantly impair rice production worldwide. Due to its wide geographical spread and long history of domestication, there exists high variability among rice cultivars throughout the tropics (Kumar *et al*., 2014). In India, the productivity of rice is very low as compared to developing countries and the reason behind this is several biotic and abiotic factors. Generally rice crop is affected mainly by more than 20 diseases. Among these, bacterial leaf blight, sheath blight, brown spot, sheath rot and blast are considered as major diseases as they reduces the yield drastically and have high destructiveness under favourable conditions (Ou, 1985). Therefore, resistance

breeding requires continuous efforts of enriching the reservoir of resistance genes/alleles to effectively tackle the disease. Rice genetic resources represent a rich stock of genetic diversity, however, they are still under-explored for identifying novel genes and/or their functional alleles

The main emphasis of global rice varietal improvement programme has been on increasing the production per unit area, followed by imparting resistance against biotic stresses, and finally on cooking and grain quality. Therefore search for appropriate donor's resistance to both biotic and abiotic stresses should be a continuous process as the resistance is not ever lasting, and due to high pathogen plasticity the single resistance gene breaks down after three to five years of the cultivar release (Lang *et al.*, 2009). Hence, development of broad spectrum and durable resistant varieties is prerequisite for combating the major diseases. Keeping this fact in view, to find out resistant/tolerant donors against the three major diseases of rice (bacterial leaf blight, sheath blight and sheath rot), screening was undertaken in the artificial condition.

Materials and Methods

The experimental materials consist of 186 diverse rice panel along with 6 checks viz., Aruna (Kerala red rice variety), Krishnanjana (Kerala red rice variety), Dubraj Selection -1 (Aromatic rice variety), Badshahbhog Selection-1 (Aromatic rice variety), Jaldubi (Submergence tolerant variety) and IGKV R-1 (Rajeshwari) (High yielding variety) were evaluated under artificial condition. Experimental material was taken from rice gene pool of IGKV, Raipur and transplanted at Research Farm, IGKV, Raipur, Chhattisgarh. The experiments were carried out for two successive years i.e. *Kharif* 2017 and *Kharif* 2018 in Augmented design, to test rice germplasm for resistance against Bacterial leaf blight (*Xanthomonas oryzae* pv. *oryzae*), Sheath blight (*Rhizoctonia solani*) and Sheath rot (*Soracladium oryzae*). Recommended dose of fertilizer was applied @N P K Kg/ha. Standard agronomical and cultural practices were followed for raising a good crop. All the rice germplasm were inoculated by the clip inoculation method, the clipper is dipped in freshly prepared inoculums before cutting the leaf tips. Five inoculated plants were selected from each line for data collection. The intensities of the diseases are recorded from the first disease symptoms till the physiological maturity at seven days interval. Observation on disease severity is recorded based on percentage of leaf/sheath area covered by particular disease. Final observation on the affected plants were recorded and graded as per 0-9 scale of Standard evaluate on system by IRRI (1980). The germplasm line exhibiting reactions 0 to 1 were considered as highly resistant, 2 as resistant, 3 to 4 as moderately resistant, 5 to 6 as moderately susceptible, 7 as susceptible and while those scored as 8 to 9 scale were highly susceptible (IRRI, 1980).

Germplasm also evaluated in the main field with Augmented design to study the *per se* performance of germplasm. Observation on yield per plant and yield related parameters were also recorded on randomly selected five plants.

Results and Discussion

The screening of one hundred ninty-two genotypes of rice against the diseases, bacterial leaf blight (BLB), Sheath blight and Sheath rot, revealed that none of the genotypes were found immune or resistant against these diseases. Bacterial leaf blight attack leaves and leaf sheath of rice plant at tillering and booting stage (Ou, 1972).

Table.1 Reaction of germplasm accessions to BLB, sheath blight and sheath rot under artificial conditions

Germplasm accessions			Recorded score	Description
Bacterial leaf blight	**Sheath blight**	**Sheath rot**		
Nil	**Nil**	**Nil**	0-1	Highly Resistant
Nil	**Nil**	**Nil**	2	Resistant
Ayepyaung, Umari, R 1882-306-4-243-1, Dubraj-11, Jaya, YNP 7066, CR 3856-29-14-2-1-1-7-1, CR 3504-12-2-1-1-1-1, Madhuraj-55, Barhasaal and Krishnanjana	Umari, R 2053-202-2-145-1 and IC : 124525	Kamini Joha and Loktimachhi	3-4	Moderately Resistant
Longku labat, Hasan Serai, NiiawHawm, Lua Nhe Den, Hawm Jan, Guinata, Dawleuang, Bongcay, Binirhen, Lalbasmati, Kalikhasa, Kamini Joha, BAS 837, Luchai (L:246), Mancha (M:1028), Luchai (L:1099), Mahipal (M:27A), Mokdo (M:550), Kankadiya (K:18 II), Khuddi (K: 1128 IV), Jira Dhan (J:53), Javaphool (J:333), Maharaji (M:504), Fundri (F:28), Banspatri (B:728), Anterved (A:217), Jaigundi (J:248), Chinnor (C:151), Keraghul (K:2034), R 2053-202-2-145-1, Shri kamal (S:660 I), R 1607-321-1-34-1, R 1661-1372-1-601-1, R 1700-2247-1-2313-1, Improved Chepti gurmatiya, Improved Dokra-dokri, R 1779-321-1-112-1, R 2054-685-1-205-1, R 1973-206-2-86-1, Sonagathi, KodhaPhool, Balamsar, Netakalani, Lahunchi, Damrubaba-3, Nardha, Mehar dhan, Kata mehar, Goindi, Luchai, Tetirpakhi, Hadrasal, IC : 41843 (Black rice), Baihaguda (Red rice), IC : 466901 (Black rice), R-RKM-1 (Black rice), Dokra dokri, Chhatri, Sugarkand, Angur guchcha, Parmal, Anjana, Mani gurmatia, Makado, Moti basmati, Bauwara, Cross 116, Kotari, Malpa, Niwari- I, IC : 116076, Nagbel, Ateya, Badshahbhog, Piso, Lonkti monchhi, Selection of Badshahbhog, Dondagi, Kadam phool, Khatiya pati, IC : 459172, IC : 460160, IC : 74637 A1, IC : 277830, IC : 323957, IC : 453927, IC : 457989, IC : 459147, IC : 449793, IC : 124346, IC : 124366, IC : 133146, IC : 135827, IC : 135877, IC : 206322, IC : 206693, IC : 206754, IC : 206866, IC : 206615, IC : 331668, IC : 379109, IC : 379122, IC : 296890, IC : 388204, IC : 389351, IC : 389838, IC : 435091, IC : 435541, IC : 435559, CR 3969-24-1-2-1-1, OR 2487-13, NPT 14-10, CR 3561-3-2-1-1-1-1, Swarna, CR 3856-44-22-2-1-10-1-5, OR 2573-11, PA 6444, NDR 359, Loktimachhi, Swarna sub-1, Bisni, Tarunbhog, Chhattisgarh Zinc Rice-1, Lalmati, O. officinalis , O. latifolia , *O. sativa* var. *fatua* (IC: 301549), *O. sativa* var. *fatua* (IC: 301558), *O. nivara* (IC: 301547), *O. nivara* (IC: 301555), *O. nivara* (IC: 301581), *O. nivara*	Lua Nhe Den, Dubraj, Mahipal, BanthaLuchai (Red rice), Mokdo (Red rice), Shri kamal (Red rice), Kankadiya (Red rice), Khuddi (Red rice), Keraghul (K:2034), Improved Chepti gurmatiya, Jaigundi, Sonagathi, Lahunchi, Netakalani, Damrubaba-3, Nardha, Dubraj 11, Newari, Piso, Lonkti monchhi, Selection of Badshahbhog, Dokra dokri, Mani gurmati, Makado, Bauwara, Kotari, Krishna Koliyari, Malpa, Surmatia, IC : 323957, IC : 457989, IC : 135827, IC : 296890, IC : 388204, Swarna, CR 3856-29-14-2-1-1-7-1, Swarna sub-1, IC : 435091, Barhasaal, *O. nivara* (IC: 301559) , *O. nivara* (IC: 301555) , *O. nivara* (IC: 301626), Karhani, Adhan chilpa, Katarni bhog, Laxmibhog, Chhatri, Dubraj (D : 1289), Aruna (Check)	Dawleuang, Kalikhasa, Umari, Shri kamal, R 1607-321-1-34-1, R 1973-206-2-86-1, Damrubaba-3, Goindi, Dubraj (Red rice), IC : 41843, Piso, IC : 277830, IC : 459147, CR 3969-24-1-2-1-1, YNP 7060, Adhan chilpa, Katarni bhog, Laxmibhog	5-6	Moderately Susceptible

(IC: 301622), *O. nivara* (IC: 301626),Karhani, Adhan chilpa, Katarni bhog, Laxmibhog, Barounda Offtype, Chhatri, Umariya chudi, Dubraj (D : 1289), Muchchhan moti, Aruna (Check), Dubraj Selection-1 (Check), Badshahbhog Selection-1 (Check) Jaldubi (Check), IGKV R1 (Rajeshwari) (Check)				
Hung-mi-hsiang-ma-Tsan, Dubraj (Red rice), Kekai (Red rice), BanthaLuchai (Red rice), Harikhuta dhan, Barabali, Bagdisona, Dubraj, Bhathaguda (Red rice), Newari, Satha Dhan, Newara, Kanji Local, Fara, Mekara ghol, Lakhouwal, Anjan, Krishna Koliyari, IC : 125267, IC : 123505, IC : 124525, IC : 388737, IC : 389509, IC : 390299, Lalloo 14, Kanak jira, *O. nivara* (IC: 301559), *O. nivara* (IC: 301584), *O. nivara* (IC: 301589), *O. nivara* (IC: 301625), *O. nivara* (IC: 301668), Chanda, Bhantha luchai	Longku labat, Hasan Serai, NiiawHawm, Hawm Jan, Hung-mi-hsiang-ma-Tsan, Guinata, Dawleuang, Bongcay, Lalbasmati, Kalikhasa, Kamini Joha, Luchai (Red rice), Mancha (Red rice), Luchai (Red rice), Jira Dhan (J:53),J avaphool (J:333), Maharaji (M:504), Fundri (F:28), Anterved (A:217), R 1607-321-1-34-1, R 1661-1372-1-601-1, R 1779-321-1-112-1, R 2054-685-1-205-1, R 1973-206-2-86-1, KodhaPhool, Harikhuta dhan, Barabali, Kata mehar, Luchai, Dubraj (Red rice), Hadrasal, Baihaguda (Red rice), Bhathaguda (Red rice), IC : 466901 (Black rice), R-RKM-1 (Black rice), Badshahbhog, Fara, Khatiya pati, Angur guchcha, Parmal, Anjana, Moti basmati, Cross 116,Niwari- I, IC : 116076, Nagbel, IC : 460160, IC : 74637 A1, IC : 277830, IC : 459147, IC : 125267, IC : 206693, IC : 206615, IC : 331668, IC : 379122,IC : 389351, IC : 389509, IC : 390299, IC : 435541, OR 2487-13, CR 3561-3-2-1-1-1-1, CR 3856-44-22-2-1-10-1-5, OR 2573-11, YNP 7060, PA 6444, Loktimachhi, Bisni, Tarunbhog, O. latifolia, *O. sativa* var. *fatua* (IC: 301558), *O. nivara* (IC: 301625), *O. nivara* (IC: 301668),Chanda (C: 287), Barounda Offtype (BOT : 61 II), Muchchhan moti (IC : 387442), Krishnanjana (Check), Badshahbhog Selection-1 (Check), Jaldubi (Check)	Longku labat, Lua Nhe Den, Hung-mi-hsiang-ma-Tsan, Guinata, Dubraj, Mahipal, Mokdo, Kankadiya, Jira Dhan, Javaphool, Fundri, Jaigundi, Chinnor, R 2053-202-2-145-1, R 1661-1372-1-601-1, R 1700-2247-1-2313-1, R 1779-321-1-112-1, Sonagathi, Kodha Phool, Nardha, Mehar dhan, Baihaguda (Red rice), Dubraj 11, Badshahbhog, Newara, Lonkti monchhi, Selection of Badshahbhog, Dondagi, Khatiya pati, Dokra dokri, Mani gurmatia, Bauwara, Niwari- I, IC : 116076, Nagbel, IC : 460160, IC : 74637, IC : 124366, IC : 125267, IC : 133146, IC : 206322, IC : 206615, IC : 296890, IC : 389838, IC : 435091, IC : 435541, OR 2487-13, JAYA, CR 3856-44-22-2-1-10-1-5, CR 3856-29-14-2-1-1-7-1, Swarna sub-1, Kanak jira, *O. officinalis*, *O. nivara* (IC: 301622), Aruna (Check), Krishnanjana (Check), Dubraj Selection-1 (Check), Badshahbhog Selection-1 (Check), Jaldubi (Check)	7	Susceptible
Nil	Binirhen, BAS 837, Ayepyaung, Kekai (Red rice), Banspatri, Chinnor, R 1700-2247-1-2313-1, Improved Dokra-dokri, R 1882-306-4-243-1, Balamsar, Bagdisona, Mehar dhan, Goindi, Tetirpakhi, IC : 41843 (Black rice), Ateya, Satha Dhan, Newara, Kanji Local, Dondagi, Kadam phool, Mekara ghol, Chhatri, Sugarkand, Lakhouwal, Anjan, IC : 459172, IC : 453927, IC : 449793, IC : 124346, IC : 124366, IC : 133146, IC : 135877, IC : 123505, IC : 206322, IC : 206754, IC : 379109, IC : 388737, IC : 389838, IC : 435559, CR 3969-24-1-2-1-1, NPT 14-10, JAYA, CR 3504-12-2-1-1-1-1, NDR 359, Madhuraj-55, Chhattisgarh Zinc Rice-1, Lalloo 14, Lalmati, Kanak jira, O. officinalis, *O. sativa* var. *fatua* (IC: 301549), *O. nivara* (IC: 301547), *O. nivara* (IC: 301581) , *O. nivara* (IC: 301584), *O. nivara* (IC: 301589), *O. nivara* (IC: 301622), Bhantha luchai,Umariya chudi, Dubraj Selection-1 (Check), IGKV R1 (Rajeshwari) (Check)	Hasan Serai, Niiaw Hawm, Hawm Jan, Bongcay, Binirhen, Lalbasmati, BAS 837, Ayepyaung, Luchai, Mancha, Luchai,Kekai, Bantha Luchai, Khuddi, Maharaji, Banspatri, Anterved, Keraghul, Improved Chepti gurmatiya, Improved Dokra-dokri, R 2054-685-1-205-1, R 1882-306-4-243-1, Balamsar, Harikhuta dhan, Barabali, Lahunchi, Bagdisona, Netakalani, Kata mehar, Luchai, Tetirpakhi, Hadrasal, Bhathaguda (Red rice),IC : 466901 (Black rice), R-RKM-1 (Black rice), Ateya, Newari, Satha Dhan, Kanji Local, Fara, Kadam phool, Mekara ghol, Chhatri, Sugarkand, Angur guchcha, Parmal, Lakhouwal, Anjan, Anjana, Makado, Moti basmati, Cross 116, Kotari, Krishna Koliyari, Malpa, Surmatia, IC : 459172, IC : 323957, IC : 453927, IC : 457989, IC : 449793, IC : 124346, IC : 135827,IC : 135877, IC :	8-9	Highly Susceptible

		123505,IC : 124525,IC : 206693,IC : 206754,IC : 206866,IC : 331668,IC : 379109,IC : 379122, IC : 388204,IC : 388737,IC : 389351,IC : 389509,IC : 390299,IC : 435559,NPT 14-10,CR 3561-3-2-1-1-1-1,Swarna,OR 2573-11, PA 6444, CR 3504-12-2-1-1-1-1, NDR 359, Madhuraj-55, Barhasaal, Bisni, Tarunbhog, Chhattisgarh Zinc Rice-1, Lalloo 14, Lalmati, *O. latifolia*, *O. sativa* var. *fatua* (IC: 301549), *O. sativa* var. *fatua* (IC: 301558),*O. nivara* (IC: 301559), *O. nivara* (IC: 301547), *O. nivara* (IC: 301555), *O. nivara* (IC: 301581), *O. nivara* (IC: 301584), *O. nivara* (IC: 301589),*O. nivara* (IC: 301625), *O. nivara* (IC: 301626), *O. nivara* (IC: 301668), Chanda, Bhantha luchai, Karhani, Barounda Offtype, Chhatri, Umariya chudi, Dubraj,Muchchhan moti, IGKV R1 (Rajeshwari) (Check),		

BLB may enhance symptom development of sheath blight and sheath rot. It may cause an average of 20-30% yield loss (Ou, 1985).

The responses of germplasm lines to bacterial leaf blight reaction were varied from moderately resistant to susceptible, indicating that the germplasm were diverse in nature. The pooled results *i.e.* of *Kharif* 2017 and *Kharif* 2018 for diseases reaction showed that eleven genotypes viz., Ayepyaung, Umari, R 1882-306-4-243-1, Dubraj-11, Jaya, YNP 7066, CR 3856-29-14-2-1-1-7-1, CR 3504-12-2-1-1-1-1, Madhuraj-55, Barhasaal and Krishnanjana were found moderately resistant (score 3-4). Such variations for leaf blight were also reported by Tasleem-uz-Zaman *et al.*, (2000); Akhtar *et al.*, (2003); Thimmegowda *et al.*, (2011) and Kumar *et al.*, (2013). The severity of the sheath blight also ranged from moderately resistant to highly susceptible (score 3-9). The three genotypes namely, Umari, R 2053-202-2-145-1 and IC : 124525 were found moderately resistant(score 3-4), whereas rest of the entries i.e. one hundred eighty-nine showed moderately susceptible, susceptible and highly susceptible reaction against sheath blight infection. These variations was also reported by Silva *et al.*, (2012), Tiwari *et al.*, (2014); Parikh *et al.*, (2016) and Pavani *et al.*, (2018).However, for sheath rot only two genotypes Kamini Joha and Loktimachhi were showed moderately resistant reaction and rest of the genotypes moderately susceptible to highly susceptible (Table 1).

It was also observed that some genotypes were showing low severity to more than one disease. Low severity for both bacterial leaf blight and sheath rot were found in Umari, CR 3856-29-14-2-1-1-7-1 and R 2053-202-1245-1. Further, the confirmation of such genotypes with resistance genes for BLB and Sheath blight needed to be done.

The genotypes CR 3504-12-2-1-1-1-1 moderately resistant for BLB, IC: 124525 moderately resistant for sheath blight and Loktimachhi moderately resistant for sheath rot were found to be significantly superior for yield per plant, the values for yield per plant was observed 30.76 g, 33.45 g and 30.96 g respectively. These genotypes can be further exploit for the development of high yielding resistant varieties.

Based on above findings it was concluded that none of the genotypes was immune towards bacterial leaf blight, sheath blight and sheath rot. Among the rice genotype, the minimum severity against all three diseases was observed in Ayepyaung, Umari, R 1882-306-4-243-1, Dubraj-11, Jaya, YNP 7066, CR 3856-29-14-2-1-1-7-1, CR 3504-12-2-1-1-1-1, Madhuraj-55, Barhasaal and Krishnanjana for bacterial leaf blight; Umari, R 2053-202-2-145-1 and IC : 124525 for sheath blight and Kamini Joha and Loktimachhi for sheath rot. Molecular validation and identification of resistance gene showing low severity reaction against all the three disease need to be done. The genotypes CR 3504-12-2-1-1-1-1 for BLB, IC : 124525 for sheath blight and Loktimachhi for sheath rot showing moderate susceptibility and were found to be significantly superior for yield per plant, whereas low severity for both bacterial leaf blight and sheath rot were found in Umari, CR 3856-29-14-2-1-1-7-1 and R 2053-202-1245-1. These genotypes identified through screening and *per se* performance of yield can be further utilized as the genetic sources in multiple diseases resistance rice breeding programme.

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