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Identification Sources of Resistance from rice Germplasm Against Sheath Rot Disease under Artificial Epiphytotic Conditions

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ABSTRACT

Twenty nine entries along with three checks were screened against sheath rot disease under artificial epiphytotic conditions during *Kharif* 2018 and 2019 to identify sources of disease resistance under field condition. Four entries designated *viz.,* NVSR-317, NVSR-411, NVSR-405 and Sambha mahsuri exhibited resistant reaction whereas, 23 entries *viz.,* NVSR-348, NVSR-350, NVSR-355, NVSR-2101, NVSR-2103, NVSR-328, NVSR-329, NVSR-2528, NVSR-2565, NVSR-2566, NVSR-330, NVSR-331, NVSR-335, NVSR-338, NVSR-360, NVSR-364, NVSR-365, NVSR-370, NVSR-374, NVSR-384, NVSR-389, NVSR-2435 and NVSR-406 showed the moderately resistant reaction and rest of the entries were recorded moderately susceptible and susceptible in their reactions against the sheath rot disease under artificial inoculation. Both susceptible checks GR-11 and TN-1 had scale-7 indicated much disease pressure with susceptible reaction. These resistant germplasm may be further utilized as donor for further breeding programs to evolve new resistant variety against sheath rot.

Key words: *Sheath rot, Rice, Resistant, Susceptible, Germplasm and reaction*

Introduction

Rice (*Oryza sativa* L.) a self pollinated crop, belonging to the family Poaceae is one of the foremost cereal food crops on which the human species largely subsists. Today two major cultivated species *viz.*, *Oryza sativa* var. *indica* and *Oryza sativa* var. *japonica* grown in Asia have spread to almost all the rice-growing areas of the world. Rice is grown in various agro-ecological zones in tropical and subtropical areas, especially in Asian countries such as India, China, Japan, Indonesia, Thailand, Pakistan, Bangladesh, North and South Korea, Myanmar, Philippines, Sri Lanka (Sharma *et al.,* 2013). The global production of rice has been estimated to be 463.52 million tonnes from an estimated area of 166.08 million hectares (FAO, 2017). India has the world's largest area under rice with 43.77 million hectares and is the second largest producer with 112.75 million tonnes next only to China with productivity of 2576 kg/ha (Anonymous, 2017).

Sheath rot, incited by *Sarocladium oryzae* (Sawada) W. Games and D. Hawksworth, which was a minor fungal disease is now causing serious threat to rice production and has shifted to the major one. Chakravarty and Biswas (1978) reported yield losses of 10-26 per cent (average estimate of 14%) due to this disease. Estrada, *et al.* (1984) reported significantly fewer spikelets per panicle and lower 1000 grain weight from severely diseased panicles compared with healthy and estimated total yield loss due to sheath rot at 53 per cent. Bigirimana, *et al.*

(2015) reported 85 per cent yield loss of rice due to sheath rot. Thus, sheath rot disease is very destructive disease to rice crop. This fungus is internally and externally seed borne, mostly survives in plant debris, weeds and soil. Secondary infection is due to sucking pest (mite) damage, where pathogen easily gets entry to flag leaf sheath. Pathogen produces mycotoxins *viz.*, cerulenin and helvoic acid responsible for production of greyish-brown necrotic lesion in flag leaf sheath and restricted translocation of photosynthesis to the developing panicles, causing quantitative and qualitative yield loss (chaffy grains) including discoloration of grains, reduced seed viability, nutritional and market value.

Host-plant resistance is the simplest and most practical disease management strategy in all crop improvement programmes. Identification of resistant or tolerant genotypes to important diseases is most economical and environmentally sound management approach in breeding program to prolong performance of varieties in the field in sustainable rice cultivation and management of disease. However, the developments of varieties with durable resistance are necessary for understanding the pathogen population, particularly regarding genetic and pathogenic variability. Thus, continuous screening for disease resistance every year is necessary due to breakdown of disease resistance. Sheath rot disease can be effectively managed through discovery of resistance sources from germplasm sources. Limited information is available on the screening of rice varieties or germplasm and the identification of resistant sources. Therefore, in this study, promising and potential germplasm lines were identified for resistance to sheath rot disease. The resistant genotypes may be used in breeding programme for development of sheath rot resistant varieties of rice.

Materials and Methods

With a view to identify the resistant entries against sheath rot, 29 entries along with three checks were screened by artificial single grain insertion method to create artificial epiphytotics under field condition during *Kharif* 2018 and 2019 at the farm of Main Rice Research Centre, NAU, Navsari. Sowing of seed of test entries was done on raised beds nursery of 10 x 1 m. Transplanting of 25 days old seedlings of each test entry was carried out in two rows each of 2m length, spaced 20cm apart, keeping plant to plant distance of 15cm. The state susceptible check GR-11 was planted after every 10th entry and all around the sheath rot screening nursery. Test entries were grown up to booting stage and artificial inoculation of the pathogen was done by single grain insertion method. All the recommended agronomical practices were adopted for raising the crop.

Periodical observations made on incidence and severity of rice sheath rot, 20 hills per plot were randomly selected and labeled. Per cent disease incidence and intensity were calculated by the formula:

Per cent disease incidence

Per cent disease incidence was calculated by using formula.

$$\text{Disease incidence (\%)} = \frac{\text{Number of diseased plants}}{\text{Total number of plant observed}} \times 100$$

Per cent disease severity

The disease severity was measured by adopting 0-9 scale (Table 1) by using standard evaluation system (SES) for rice developed by International Rice Research Institute, Philippines (IRRI, 2013). Further, the disease severity was calculated using the following formula. Subsequently, the data on disease severity were collected and subjected to statistical analysis:

$$\text{Disease severity (\%)} = \frac{\text{Sum of the individual disease ratings}}{\text{Total no. of leaves observed} \times \text{Maximum grade}} \times 100$$

Results and Discussion

In present study, advanced generation genotypes screened against sheath rot, accordingly, genotypes were grouped under different disease reaction categories based on 0-9 scale as suggested by IRRI (2013) and results presented in table 2 and 3. The data indicated that, among 29 entries along with three checks genotypes tested, none of the genotype showed highly resistant reaction to sheath rot disease. However, four entries designated *viz.,* NVSR-317, NVSR-411, NVSR-405 and Sambha mahsuri exhibited resistant reaction whereas, 23 entries *viz.*, NVSR-348, NVSR-350, NVSR-355, NVSR-2101, NVSR-2103, NVSR-328, NVSR-329, NVSR-2528, NVSR-2565, NVSR-2566, NVSR-330, NVSR-331, NVSR-335, NVSR-338, NVSR-360, NVSR-364, NVSR-365, NVSR-370, NVSR-374, NVSR-384, NVSR-389, NVSR-2435 and NVSR-406 showed the moderately resistant reaction and rest of the entries were recorded moderately susceptible and susceptible in their reactions against the sheath rot disease.

Both susceptible checks GR-11 and TN-1 had scale-7 indicated much disease pressure with susceptible reaction. Whereas highest disease incidence (42.88%) and severity (33.33%) of sheath rot disease were recorded in susceptible state check GR-11 which was followed by national susceptible check TN-1 (35.90% and 28.89%) and genotypes, NVSR-2526 (25.61% and 18.33%), NVSR-367 (24.76% and 18.89%), respectively. The lowest disease incidence (1.11%) and severity (0.56%) was recorded in geno-

Table 1. Disease severity rating scales for sheath rot of rice

Score	Description	Disease reaction
0	No lesion/ spot on flag leaf sheath	Highly Resistant
1	Spots visible on the tillers upon very careful examination (less than 1 per cent flag leaf sheath area covered)	Resistant
3	Spots visible on the tillers upon careful examination (1 to 5 per cent flag leaf sheath area covered)	Moderately resistant
5	Spots easily visible on tillers (6 to 25 per cent flag leaf sheath area covered)	Moderately susceptible
7	Spots present on almost whole the tillers parts (26 to 50 per cent flag leaf sheath area covered)	Susceptible
9	Spots very common on whole tillers parts (51 to 100 per cent flag leaf sheath area covered) death of plants common, reduced severe yield loss	Highly susceptible

Table 2. Screening of rice entries from advance genotypes against sheath rot

Sr. No.	Genotypes	Per cent disease incidence			Per cent disease severity			Score	Reaction
		2018	2019	Pooled	2018	2019	Pooled		
1	NVSR-317	1.11	2.83	1.97	0.56	1.11	0.83	1	R
2	NVSR-348	3.13	5.64	4.38	2.22	2.78	2.50	3	MR
3	NVSR-350	6.30	7.18	6.74	3.89	4.44	4.17	3	MR
4	NVSR-355	2.45	3.41	2.93	1.67	2.22	1.94	3	MR
5	NVSR-411	0.71	1.50	1.11	0.56	0.56	0.56	1	R
6	NVSR-2101	6.23	7.14	6.69	3.89	4.44	4.17	3	MR
7	NVSR-2103	3.54	4.87	4.21	2.22	2.78	2.50	3	MR
8	NVSR-328	5.81	6.52	6.16	3.89	4.44	4.17	3	MR
9	NVSR-329	6.41	8.04	7.22	4.44	5.00	4.72	3	MR
10	NVSR-2526	24.02	27.2	25.61	17.78	18.9	18.33	5	MS
11	NVSR-2528	2.71	3.28	3.00	1.11	2.78	1.94	3	MR
12	NVSR-2565	2.78	5.15	3.96	1.11	1.67	1.39	3	MR
13	NVSR-2566	6.42	7.96	7.19	3.33	3.89	3.61	3	MR
14	NVSR-330	5.38	8.82	7.10	3.33	4.44	3.89	3	MR
15	NVSR-331	5.06	9.53	7.30	3.89	5.00	4.44	3	MR
16	NVSR-335	5.83	8.57	7.20	3.89	4.44	4.17	3	MR
17	NVSR-338	4.03	7.33	5.68	2.78	3.33	3.06	3	MR
18	NVSR-360	6.04	9.86	7.95	4.44	5.00	4.72	3	MR
19	NVSR-364	5.89	7.20	6.54	3.89	4.44	4.17	3	MR
20	NVSR-365	5.42	7.43	6.42	3.33	4.44	3.89	3	MR
21	NVSR-367	24.34	25.17	24.76	18.33	19.44	18.89	5	MS
22	NVSR-370	5.30	7.06	6.18	3.33	3.89	3.61	3	MR
23	NVSR-374	5.56	6.29	5.92	3.89	4.44	4.17	3	MR
24	NVSR-384	4.35	5.51	4.93	2.78	3.33	3.06	3	MR
25	NVSR-389	3.75	5.30	4.53	2.78	3.33	3.06	3	MR
26	NVSR-405	1.25	2.22	1.74	0.56	1.00	0.78	1	R
27	NVSR-2435	3.13	3.86	3.49	2.22	2.78	2.50	3	MR
28	NVSR-406	4.65	4.94	4.80	2.78	3.33	3.06	3	MR
29	NVSR-407	21.40	22.01	21.70	17.22	19.44	18.33	5	MS
30	Sambha Mahsuri (RC)	0.71	1.67	1.46	0.56	0.60	0.58	1	R
31	GR-11 (SC)	41.57	44.19	42.88	31.67	35.00	33.33	7	S
32	TN-1 (NSC)	34.56	37.24	35.90	25.00	32.78	28.89	7	S

type NVSR-411 which was followed by state resistant check Sambha masuri (1.46% and 0.58%) and the genotype, NVSR-405(1.74% and 0.78%).

Thus, out of 29 genotypes tested (Table 3) along with three susceptible checks, four genotypes were found resistant whereas, 23 genotypes were found moderately resistant, three genotypes were moderately susceptible and two genotypes found susceptible to *Sarocladium oryzae* under artificial inoculation. However, genotypes or entries screened here are new entries, so no specific information was available related to these genotypes against sheath rot of paddy. Thus, it can be suggested for scientific community to use the moderately resistant genotypes for further breeding programs to evolve new resistant variety against sheath rot.

These results are in confirmation with the findings of Kindo *et al.* (2015), who evaluated twenty two scented varieties against sheath rot resistance by half cooked rice grain spore coated inoculation method and showed that the eighteen entries designated as Jeera basmati, Tarun bhog, Adanchini, Dhanprasad, Chinnor, phool, Londhi, Jaiphoola, Chinor, Gopal bhog, Dujai and Kubrimohar were recorded in moderately resistance reactions (Score-5) and the five entries *viz.,* Dubraj, Pusa basmati, Badsahbhog and Jeeraphool were recorded with susceptible reactions (Score-7).

Singh and Das (2016) screened twenty aromatic rice varieties against sheath rot disease at Assam under field conditions during *Kharif* season of 2015. Eight entries *viz.,* Boga Jalsi, Boga Joha, Monika madhuri Joha, Goul poriya Joha, Bokul Joha, Tulasi Joha, Monipuri Joha, Keteki Joha were recorded as highly resistant (Score-1). Three entries *viz.,* Govinda Bhog, Kon Joha and Koli Joha were recorded as resistant (Score-3). Five entries *viz.,* Kola Joha, Kaljira Joha, Rampal Joha, Ronga Joha, Kanbagi Joha were recorded as moderately resistant (Score-5). Four entries *viz.,* Kameni Joha, Badshabhog, Jalsa Joha and Krishna Joha were recorded as susceptible reactions (Score-7) and none of the variety was recorded as highly susceptible reactions (Score-9).

Chauhan *et al.* (2017) assessed eight commercially grown rice cultivars for severity and frequency of sheath rot occurrence under natural epiphytotic conditions at experimental farm of Rice Research Station, Kaul (Haryana). The sheath rot (*S. oryzae*) disease appeared in all the cultivars at boot leaf stage and predominant pathogen in cultivars Jaya and IR-64 with 73.3 and 60.0 per cent, respectively. Whereas, it was least frequent in HKR-126 (6.7%) closely followed by varieties PR-106 and HKR-46.

Pushpam *et al.* (2019) screened 43 rice lines against sheath rot, among them four germplasm lines Swarna, Kattanur, Dhalaheera and JGL 3855

Table 3. Reactions of the rice entries from advance genotypes against sheath rot of rice

Score	Description	Disease reaction	Total genotypes	Name of genotypes
0	No lesions/ spot on flag leaf sheath.	Highly Resistant	0	NIL
1	less than 1 per cent flag leaf sheath area covered	Resistant	4	NVSR-317, NVSR-411, NVSR-405 and Sambha mahsuri
3	1 to 5 per cent flag leaf sheath area covered	Moderately resistant	23	NVSR-348, NVSR-350, NVSR-355, NVSR-2101, NVSR-2103, NVSR-328, NVSR-329, NVSR-2528, NVSR-2565, NVSR-2566, NVSR-330, NVSR-331, NVSR-335, NVSR-338, NVSR-360, NVSR-364, NVSR-365, NVSR-370, NVSR-374, NVSR-384, NVSR-389, NVSR-2435 and NVSR-406
5	6 to 25 per cent flag leaf sheath area covered	Moderately susceptible	3	NVSR-2526,NVSR-367, NVSR-407
7	26 to 50 per cent flag leaf sheath area covered	Susceptible	2	GR-11 and TN-1
9	51 to 100 per cent flag leaf sheath area covered	Highly susceptible	0	NIL

have been reported resistant to sheath rot. Six entries were categorised as moderately resistant. Most of the lines and varieties were found as moderately susceptible. However, Sixteen germplasm lines were designated as susceptible and three germplasm lines viz., Athira, Malampunchan, Adukan were found as highly susceptible. None of the entry was recorded as immune.

Conflict of Interest- None

References

Anonymous, 2017. www.indiastat.com-2017.

Bigirimana, V.D.P., Hua, G.K.H., Nyamangyoku, O.I. and Hofte, M. 2015. Rice sheath rot: An emerging ubiquitous destructive disease complex. *Frontier in Plant Sci*ence. 6: 1-16.

Chakravarty, D. K. and Biswas, S. 1978. Estimation of yield loss in rice affected by sheath rot. *Plant Disease Reporter.* 62: (3): 226- 227.

Chauhan, R.S. Yadav, N.K. and Saini, A.K. 2017. Disease incidence/severity and frequency of pathogens (*Sarocladium oryzae* and *Fusarium moniliforme*) associated with sheath rot in commercial rice cultivars. *Annals of Biology*. **33**(1): 98-100.

Estrada, B.A., Torres, C.Q. and Bonman, J.M. 1984. Effect of sheath rot on some yield components. *International Rice Research Newsletter.* 9(2): 14.

FAO, 2017. FAOSTAT Agriculture data [online]. In: http://www.fao.org and http://faostat.fao.org/ (last update 2017). Rome, Italy: Food and Agriculture Organization (FAO).

IRRI, 2013. Standard of evaluation system for rice. The international rice testing programme. Genetic resources centre, International Rice Research Institute. Manilla, Philippines, Pp: 20-21.

Kindo, D., Bhagat, R.K. and Tiwari, P.K. 2015. Screening of aromatic rice entries against sheath rot of rice under field condition. *Trends in Biosciences.* 8(2): 462-463.

Pushpam, R., Nithya, N., Fathima Nasrin, S., Meena, E., Ramamoorthy, K., Parthiban, V.K. and Arumugam Pillai, M. 2019. Screening of rice cultivars for resistance to sheath rot (*Sarocladium oryzae*). *Electronic Journal of Plant Breeding.* 10 (2): 377-381.

Sharma, L., Nagrale, D.T., Singh, S.K., Sharma, K.K. and Sinha, A.P. 2013. A study on fungicide potential and incidence of sheath rot of rice caused by *Sarocladium oryzae* (Sawada). *Journal of Applied and Natural Science.* 5(1): 24-29.

Singh, M. and Das, B.C. 2016. Screening of aromatic rice (Joha) genotypes against sheath rot disease of rice and its management under field condition. *International Journal of Advanced Research*. 4(4): 922-925.