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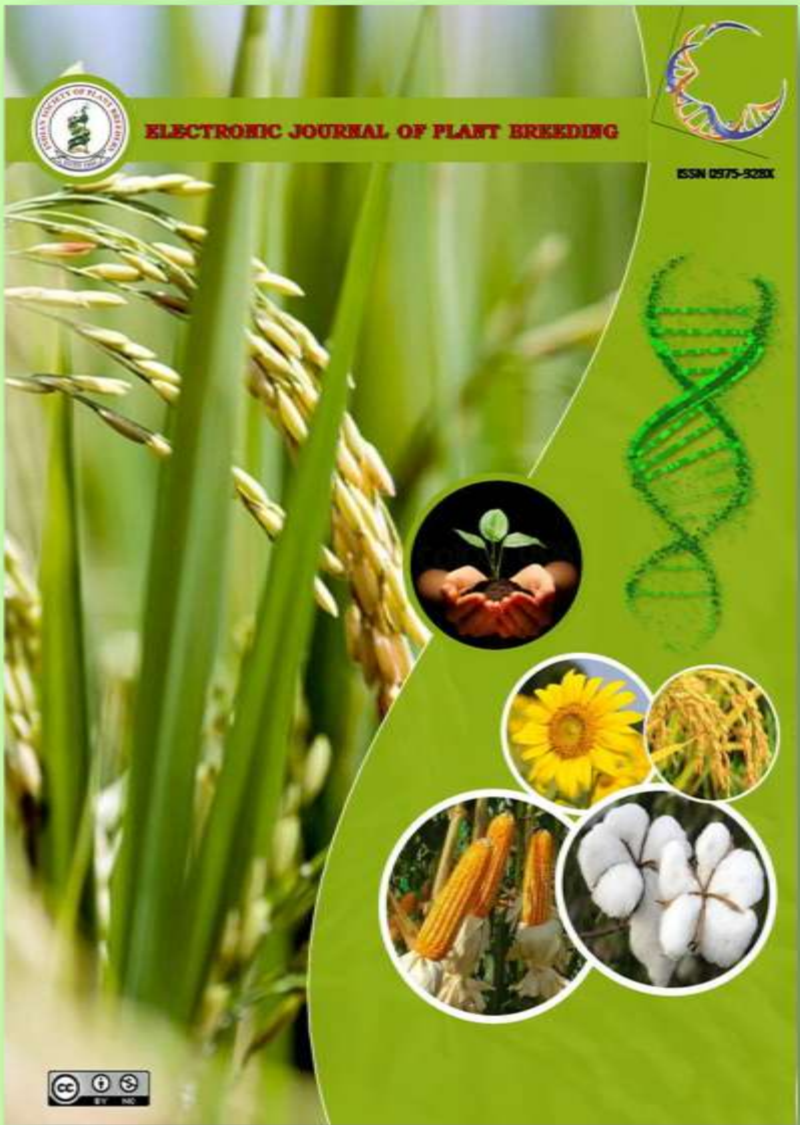

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Research Article

Screening of rice cultivars for resistance to sheath rot (S*arocladium oryzae*)

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Abstract
Rice sheath rot has become a highly destructive rice disease with a high variability in yield loss levels varying from 20 to 85%. It is caused by many pathogenic agents varying depending on the area, grown varieties, prevailing environmental conditions, the farming system, other pests, etc. Therefore, sheath rot disease can be effectively managed through crop improvement strategies *viz.,* discovery of resistance sources from varieties, germplasm, landraces, wild genetic resources and further deploying them in breeding programmes. In this study, the level of resistance to sheath rot in 43 rice germplasm accessions were screened and the results were grouped using Darwin 6.0 statistical package from dissimilarity analysis. The percent disease index (PDI) was calculated and varietal reactions were presented. Out of 43 lines screened against sheath rot, six entries *viz.,* Gowri, NLR 3449, Navara, Soorakkuruvai, Keralakandasala, krishnahemavathi were categorised as moderately resistant. Most of the lines and varieties *viz.,* JGL 348, Abhya, LFR293, MDU5, Kalinga, Annada, Kodaikannan, TP-100008, TP-10106, Kuruvaikalanjium, Kalyani, Maranella, Seeragasamba, Thondi, Kavara, TPS-4, TPS-5, TP 08053 were found as moderately susceptible. However, the germplasm lines Swarna, Kattanur, Dhalaheera and JGL 3855 have been reported to be resistant to sheath rot. Sixteen germplasm lines *viz.,* Bharathi, Uma, CO 39, Neikuruvai, CO 50, Rajalakshmi, Karsamba, JGL 1798, CO 51, BPT 5204, Virendra, JGL 1798, CO 51, BPT 5204 and Aman were designated as susceptible and three germplasm lines *viz.,* Athira, Malampunchan, Adukan were found as highly susceptible. None of the entry in the present study was recorded as immune. The present investigation revealed that the resistant and moderately resistant genotypes *viz.,* Swarna, Kattanur, Dhalaheera, JGL 3855, Gowri, NLR3449, Navara, Soorakuruvai, Keralakandasala, and Krishnahemavathi can be utilised in resistant breeding programmes for the development of sheath rot resistant lines in rice.

Key words
Rice sheath rot, S*arocladium oryzae,* rice cultivars, Percent disease Index

Introduction

Rice is one of the most important and widely cultivated food crops of the world and the majority of rice (90 per cent) is being produced in Asian countries, China and India being the major producers (IRRI, 2013). India is the leading rice (*Oryza sativa*) producing country in terms of area and the second largest producer next to China. Rice plays an important role in food as well as livelihood security of almost every household, more so in West Bengal delta. Current production of rice is about 106 MT whereas the total world production is 700 MT accounting for a total area of 158 m ha. Rice cultivation and productivity has been affected by many yield limiting factors. Among those, pests and diseases cause about 25 % yield loss. Around one century ago, a rice disease characterised mainly by rotting of sheaths was reported in Taiwan. The causal agent was identified as *Acrocylindrium oryzae*, later known as *Sarocladium oryzae*.

Sheath rot infects the rice plant at all the growth stages, but it is most destructive when infection occurs during or after the booting stage, before the emergence of panicle. It caused 20-85 % yield loss in Taiwan 30- 80 % in Vietnam, Philippines and India. In Japan, affected areas ranged from 51000 – 122000 hectares and annual losses are estimated to be 16000 – 35000 tonnes. The average reduction in grain yield due to this disease was estimated to be 57.40% in Tamil Nadu.

The pathogen mainly infects the uppermost leaf sheath and retards the translocation of nutrients from foliage to panicle. *Sarocladium oryzae* is primarily seed borne and survives on plant debris and weeds, disseminates conidia through wind and sucking pests. Pathogen produces phytotoxins *viz.,* Cerulenin and helvoic acid which are responsible for the production of characteristic greyish brown lesion on flag leaf sheath and discolouration of grains, glume discolouration and also seed discolouration. It also causes poor grain filling and reduction in seed germination.

Due to Changes in Agriculture, because of global warming, there are also changes in plant health, some diseases becoming more important than before, like sheath rot, which is now becoming a serious threat to rice production. It is proven that most sheath rot associated pathogens have an endophytic (latent) phase in their lifecycle, waiting for the plant to become stressed so that they can attack it (Fisher and Petrini, 1992).

Rice sheath rot has become a highly destructive rice disease with a high variability in yield loss levels varying from 20 to 85%. It is caused by many pathogenic agents depending on the area, grown varieties, prevailing environmental conditions, the farming system, other pests, etc. Not much progress has been achieved in the control of the disease, partly because the etiology of the disease is difficult to establish. For managing the disease, a better understanding about the disease is needed. As rice sheath rot disease is complex by nature, its control strategy must be inspired by the Integrated Pest Management (IPM) approach. The solution remains site-specific. Limiting the number of potential pathogens harboured by the plant, making the plant environment less conducive to pathogen development, etc. should be the central elements in the control approach, which can be complemented by other methods.

At present, sheath rot of rice cannot be effectively controlled by chemical means alone. Moreover, use of fungicide to control disease causes several adverse effects like development of resistance in the pathogen, residual toxicity, pollution to the environment etc., Therefore, sheath rot disease can be effectively managed through crop improvement strategies *viz.*, discovery of resistance sources from varieties, germplasm, landraces, wild genetic resources and further deploying them in breeding programmes. In this study, the level of resistance to sheath rot in 43 rice germplasms were screened and the results were grouped using Darwin 6.0 statistical package from dissimilarity analysis.

Materials and Methods

The study was conducted at the Department of Plant Breeding and Genetics at Agricultural College and Research Institute, Killikulam during Pisanam season of 2017-18. Forty-three germplasm lines were selected for this study supplied by Department of Plant Breeding and Genetics, TNAU. For each entry two rows were raised with a spacing of 20 x15 cm with two replications. All recommended agronomic practices were followed and the trial was conducted under irrigated condition. The disease resistance of commercial rice cultivars and the native germplasm was evaluated in naturally infected fields. They were screened for sheath rot resistance after heading stage on the basis of the development of the disease symptoms by recording percent disease severity and disease score. Observations on disease severity were recorded at mature flag leaf sheath on randomly selected 10 plants by using 0-9 rating scale given by standard evaluation system, IRRI (2013). The results were statistically analysed by using Darwin 6.0 statistical package.

SES Scale

Score	Description
0	No incidence
1	Less than 1%
3	1 – 5%
5	6 – 25 %
7	26 – 50 %
9	51 – 100 %

The Percent Disease Index (PDI) was calculated using standard formula;

$$\text{PDI \%} = \frac{\text{Sum of all disease ratings} \times 100}{\text{Total no. of sample observed} \times \text{maximum disease rating}}$$

Varietal reactions are recorded following the method as described by Sharma *et.al.* (2013).

Percent disease index (PDI)		**Varietal reaction (VR)**
0%	-	Immune
1-10%	-	Resistant
11-25%	-	Moderately resistant
25-50%	-	Moderately susceptible
50-75 %	-	Susceptible
76-100%	-	Highly susceptible.

Results and Discussion

Forty three germplasm lines were screened against sheath rot under natural conditions and the severity of sheath rot was recorded on selected infected tillers. The percent disease index (PDI) was calculated and varietal reactions were presented in Table 1. The results were grouped using Darwin 6.0 statistical package for dissimilarity analysis.

Out of forty-three lines screened against sheath rot, six entries *viz.*, Gowri, NLR 3449, Navara, Soorakkuruvai, Keralakandasala, krishnahemavathi were categorized as moderately resistant. Most of the lines and varieties *viz.*, JGL 348, Abhya, LFR293, MDU5, Kalinga, Annada, Kodaikannan, TP-100008, TP-10106, Kuruvaikalanjium, Kalyani, Maranella, Seeragasamba, Thondi, Kavara, TPS-4, TPS-5, TP 08053 were found as moderately susceptible.

However, the germplasm lines Swarna, Kattanur, Dhalaheera and JGL 3855 have been reported to be resistant to sheath rot. Remaining 16 germplasm lines *viz.,* Bharathi, Uma, CO 39, Neikuruvai, CO 50, Rajalakshmi, Karsamba, JGL 1798, CO 51, BPT 5204, Virendra, JGL 1798, CO 51, BPT 5204 and Aman were designated as susceptible and three germplasm lines Athira, Malampunchan, Adukan were found as highly susceptible. None of the entry in the present study was recorded as immune. Chung (1975) observed slight to moderate incidence of sheath rot on indica varieties, IR lines and IR varieties while recommended japonica varieties were disease free. Amin *et. al.* (1974) observed sheath rot on dwarf and local tall varieties and concluded that the dwarf varieties appeared to be more prone to sheath rot because of their shortened internodes and poor exertion of the panicle from the flag leaf sheath.

Ayyadurai *et al.* (2005) analysed *Sarocladium oryzae* isolates from North East and South India and found a high variability in pathogenicity, phytotoxic metabolite production, and RAPD band patterns. This variability should be taken into account in breeding efforts. Breeding for resistance to sheath rot seems to the best option, but it is limited by its multiple causal agents. High-yielding nitrogen-responsive rice cultivars are highly susceptible to sheath rot. Resistance to *S. oryzae* has been identified in tall rice varieties (Amin., 1976 ; Hemalatha *et al.,*1999).

The use of biological control agents may have potential (Sakthivel and Gnanamanickam, 1987; Mew *et al.,* 2004). Many pseudomonads can act efficiently for controlling S. *oryzae*, by favouring antagonism, for example through the inhibition of fungal development as do some *P. fluorescens* strains, or by inducing systemic resistance (Saravanakumar *et al.,* 2009). The present investigation revealed that the resistant and moderately resistant genotypes *viz.,* Swarna, Kattanur, Dhalaheera, JGL 3855, Gowri, NLR3449, Navara, Soorakuruvai, Keralakandasala, Krishnahemavathi can be utilized in resistant breeding programmes for the development of sheath blight resistant lines in rice.

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Table 1. Reaction of rice cultivars for sheath rot

S.NO	VARIETIES	PDI (%)	VARIETAL REACTION
1	Swarna	4.44	Resistant
2	Kattanur	6.66	Resistant
3	Gowri	14.44	Moderately resistant
4	Bharathi	66.66	Susceptible
5	Uma	51.11	Susceptible
6	JGL 348	37.77	Moderately susceptible
7	CO 39	53.33	Susceptible
8	TP08053	43.60	Moderately susceptible
9	Abhaya	31.11	Moderately susceptible
10	LFR 293	33.33	Moderately susceptible
11	MDU 5	34.44	Moderately susceptible
12	Athira	77.77	Highly susceptible
13	Kalinga	25.50	Moderately susceptible
14	Dhala heera	6.66	Resistant
15	JGL 3855	10.00	Resistant
16	Annada	31.10	Moderately susceptible
17	Kodaikannan	26.60	Moderately susceptible
18	TP 100008	41.11	Moderately susceptible
19	TP 10106	33.33	Moderately susceptible
20	Kuruvaikalaijium	26.60	Moderately susceptible
21	Neikuruvai	62.22	Susceptible
22	Kalyani	31.10	Moderately susceptible
23	CO 50	71.10	Susceptible
24	Rajalakshmi	61.10	Susceptible
25	Maranellu	45.50	Moderately susceptible
26	Seeraga samba	41.10	Moderately susceptible
27	Thondi	46.60	Moderately susceptible
28	Karsamba	51.11	Susceptible
29	Mulampunchan	82.22	Highly susceptible
30	Kadaikannan	46.66	Moderately susceptible
31	Adukan	77.77	Highly susceptible
32	JGL 1798	73.33	Susceptible
33	CO 51	68.88	Susceptible
34	BPT 5204	50.00	Susceptible
35	Navara	40.00	Moderately susceptible
36	Virendra	51.11	Susceptible
37	TPS 5	42.22	Moderately susceptible
38	Aman	62.30	Susceptible
39	NLR 3449	15.80	Moderately resistant
40	Soorakkuruvai	11.40	Moderately resistant
41	Kerala Kandasala	12.90	Moderately resistant
42	Krishnahemavathi	14.42	Moderately resistant
43	TP0 8053	43.60	Moderately susceptible

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Dissimilarity Analysis by Using Darwin 6.0