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SURVEY ON THE INCIDENCE OF RICE SHEATH ROT DISEASE AND ASSESSING THE CULTURAL CHARACTERS AND PATHOGENICITY OF *SAROCLADIUM ORYZAE*

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Abstract

Rice sheath rot is caused by *Sarocladium oryzae* also one of the major factor of rice production constrain. Hence, the present study was conducted with an objective to assess the prevalence and incidence of rice sheath rot disease in different regions of Nagapattinam district, Tamil Nadu, India during 2009 and assess the cultural characters and pathogenic variability among the isolates of *S. oryzae.* The survey clearly revealed that the disease incidence ranged from 12.32 to 30.43 per cent showing the endemic nature of the disease. Among the media tested both solid and liquid, PDA and PD broth was found to be the best in supporting the mycelial growth (4.55cm) and mycelial dry weight (317.34mg) of the pathogen. Among the isolates SO_{17} was found as the most virulent which recorded maximum per cent disease incidence (58.33%) with maximum lesion size 39.40 mm length and 5.31 mm width on rice variety ADT 39. Also, the study proved that grain inoculation method is a best in taking infection and affecting crop among the different methods of artificial inoculation tested.

Key words **:** *Sarocladium oryzae,* Rice, Survey, Disease incidence, Pathogenic variability.

Introduction

Rice (*Oryza sativa* L.) is the world's most important crop and a primary source of food for more than half of the world's population and grown in various agro-ecological zones in tropical and subtropical areas, especially in Asia, the continent accounting for 90% of the world population (IRRI, 2015). FAO's forecast of global paddy production in 2017-18 stands at 484 Million Tonnes, and aggregate rice production in India at 110.15 Million Tonnes in milled basis (FAOSTAT, 2018). Among the various production constrains of rice, sheath rot disease is caused by *Sarocladium oryzae* (Sawada) Gams and Hawksworth has become a major production constraint in rice because of its ability to defoliate or remove the chlorophyll content of the leaves and to produce the chaffy grains by hindering translocation of nutrients from foliage to panicle leading to considerable reduction in yield (Rice Knowledge Bank, IRRI, 2014). Sheath rot disease occurs in most rice-growing regions of the world especially Vietnam, Phillipines, India and usually causes yield losses ranging from 20 to 85% (Naeimi *et al.,* 2003; Anon, 2012; Bigirimana *et al.,* 2015). Thus, sheath rot disease is very destructive to rice crops the present study was conducted with an objective to assess the prevalence and incidence of sheath rot of rice in different regions of Nagapattinam district, Tamil Nadu, India and assess the cultural characters and pathogenic variability among the isolates of *S. oryzae.*

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Materials and Methods

An intensive fixed plot survey was conducted to find out the occurrence of disease incidence and severity of sheath rot in some major paddy growing regions of Nagapattinam district. Rice fields from twenty localities of five regions *viz*., Nagapattinam, kilvelur, Vedaranyam, Mayiladuthurai and Sirkali were surveyed. In each region, five villages were selected for survey and in each village five fields were selected. In each field, five plots of one square meter area were selected randomly. Sheath rot incidence and severity were recorded using 0-9 scale and formula proposed by Vivekananthan *et al*., (2005).

Scale used for grading

Grade	Description
0	No incidence
1	Less than 1 per cent sheath area affected
3	1-5 per cent sheath area affected
5	6-25 per cent sheath area affected
7	26-50 per cent sheath area affected
9	51-100 per cent sheath area affected

$$PDI = \frac{Sum\,of\ Individual\,rating}{Total\,no.of\ tillers\,observed} \times \frac{100}{\max imum\,grade}$$

$$Disease\,severity = \frac{Area\,of\ leaf\ sheath\,infected}{Total\,leaf\ sheath\,area}$$

Isolation and identification of *S. oryzae*

Sheath rot pathogen *S. oryzae* was isolated from the diseased rice sheaths showing the typical lesions of sheath rot. The edge of the lesions was cut into small pieces by means of a sterile knife. Then the pieces were surface sterilized in 0.1 per cent sodium hypochlorite solution for 30 seconds washed in three repeated changes of sterile distilled water and then plated into Petri dishes containing PDA medium. The plates were then incubated at room temperature 28±2°C. The tip of the hyphal growth radiating from the infected tissue was transferred into PDA slants (Rangaswami, 1972). The fungus was purified again by single hyphal tip method and maintained on PDA slants for the further studies.

Growth on solid media

The following media were used for assessing the growth of *S. oryzae*

1. Potato Dextrose agar medium (Ainsworth, 1961)
2. Oat meal agar medium (Booth, 1971)
3. Czepek's Dox agar medium (Dox, 1910)
4. Richard's medium (Fahmy, 1923)
5. Carrot Dextrose agar medium (Pandey and Vishwakarma, 1998).
6. Radish Dextrose agar medium (Pandey and Vishwakarma, 1998).

A nine mm culture disc from a 15 days old PDA culture of the pathogen was removed using a sterilized cork borer and placed at the center of sterile Petri dishes containing 20 ml of respective media under aseptic conditions. Three replications were maintained for each isolate in each medium. Fifteen days after incubation at room temperature (28±2°C) the mycelial growth of the isolates was assessed and recorded.

Growth on liquid media

Six liquid media *viz*., potato dextrose broth, carrot dextrose broth, oat meal broth, Czepek's dox broth, Radish broth and Richard's broth were prepared and 100 ml of the respective medium was dispensed in 250 ml Erlenmeyer flasks, autoclaved at 1.4 kg/cm^2 for 20 minutes and cooled. The flask was inoculated separately with fifteen days old 9mm PDA culture disc of the respective isolate of *S. oryzae*. The flasks were incubated at room temperature 28±2°C for 15 days. Three replications were maintained for each isolate in each medium. After incubation the mycelial mat was filtered through a pre weighed Whatman No.1 filter paper and then dried in hot air oven at 60°C till a constant weight was obtained. The mycelial dry weight was calculated by subtracting from the weight of the filter paper and recorded.

Morphological characters

A nine mm culture disc from a 15 days old PDA

Table 1: Survey for the incidence and severity of sheath rot incited by *S. oryzae*.

Sl. No.	Regions	Locality	Variety	Per cent Disease Incidence (PDI)	Per cent severity
1.	Nagapattinam	Nagoor	TKM 9	12.32	10.11
2.		Thirmarugal	ADT 36	24.57	24.31
3.		Polagam	ADT 43	22.01	23.31
4.		Sembiyamadevi	ADT 36	24.07	22.33
5.	Kilvelur	kilaiyur	ADT 39	22.31	22.71
6.		Okkur	ADT 39	21.31	25.04
7.		Valivalam	ADT 39	28.48	28.90
8.		Karunkanni	ADT 39	25.38	27.38
9.	Vedaranyam	Vadamalai	TKM 9	17.81	28.31
10.		Vettaikaranirupu	ADT 36	20.01	28.90
11.		Talaignayiru	TKM 9	14.42	12.87
12.		Vadamalai	TKM 9	18.48	16.31
13.	Mayiladuthurai	Kodankudi	ADT 39	29.68	30.49
14.		Pattavarthi	ADT 43	25.68	25.79
15.		Kuthalam	ADT 36	26.32	28.25
16.		Villiyanallur	ADT 39	27.50	28.38
17.	Sirkali	Kathiramangalam	ADT 39	30.43	32.41
18.		Kollidam	ADT 43	19.80	20.72
19.		Sembanarkoil	ADT 43	20.20	20.37
20.		Nimeli	ADT 36	24.32	28.38

culture of the pathogen was removed using a sterile cork borer and placed at the center of sterilized Petri dishes containing 20 ml of PDA under aseptic conditions. Fifteen days after incubation at room temperature (28±2°C) the mycelial growth and morphological characters of the isolates were observed. The morphological characters *viz*., growth and colour of the mycelium, shape and size (length and width) of the conidia were observed, measured and recorded (CMI, 1980).

Effect of different inoculation methods in the incidence of sheath rot

Three inoculation methods were tested on rice variety ADT 39 under pot culture conditions. The pots (30×45cm) were planted with 25 days old seedlings and maintained following standard agronomic practices. Water congestion was provided to the inoculated plants both 24h prior and after inoculation by spraying the plants with sterile water and covering with polythene bags. Rice plants without inoculation served as control. Fourteen days after inoculation the per cent tillers infected was observed. Five replications and three pots were maintained for each treatment.

Grain inoculation method

The pathogen was multiplied on paddy chaffy grains in 250ml conical flasks. Fifty ml of water was added to 200 g of paddy grains and sterilized. The flasks were aseptically inoculated with a 9mm culture disc of 15 day's old *S. oryzae*. Then the flaskswere incubated at 28±2^{0}C for 20 days. After incubation, the chaffy grains fully covered with the fungus were used as inoculum. At the boot leaf stage of the plants, single grain culture of each isolates with well developedmycelial growth were placed in between boot leaf sheath and panicle in each tiller after making slight pinprick injury with the help of a sterile entomological pin and covered with moist cotton (Sakthivel and Gnanamanikam, 1987).

Sheath inoculation method

In this method infected sheaths were cut into small pieces and then inserted in between the flag leaf sheath and covered with moist cotton (Narayanaprasad *et al.,* 2011).

Spore suspension method

Well grown fungus on potato dextrose agar medium was scraped off from the surface and mixed in sterile distilled water to obtain spore suspension (5×10^7 spores/ml). One drop of spore suspension was placed by sterilized plastic dropping bottle inside the flag leaf sheath enclosing the unemerged panicle (Narayanaprasad *et al.,* 2011).

Pathogenicity of *S. oryzae*

Rice plants of susceptible cultivar ADT 39 were raised from surface sterilized seeds in cement pots. In each pot six hills were maintained. The upper most flag leaves of tillers at the booting and the panicle emerging stages were inoculated with *S. oryzae* isolates by the standard grain inoculum technique (Sakthivel and Gnanamanickam, 1987). The incidence of sheath rot disease was recorded 14 days after inoculation using of 0-9 scale proposed by Vivekananthan *et al*., (2005). The severity of sheath rot disease was recorded by measuring the length of the lesions. The pathogen was re-isolated from the artificially infected plants and compared with the original isolate maintained in the laboratory.

Table 2 : Growth of *S. oryzae* isolates on different solid media.

Isolates	Mycelialgrowth (cm)					
	PDA medium	Czepek'sDox agar medium	Carrot dextrose agar medium	Oat meal agar medium	Richards medium	Radish dextrose agar medium
So_1	4.26_f	3.81_d	3.60_e	3.56_d	3.43_d	3.07_e
So_2	4.36_f	3.63_f	3.37_g	3.25_h	3.23_h	2.80_h
So_3	4.74_c	3.63_f	3.48_e	3.46_e	3.18_e	2.45_i
So_4	4.38_e	3.65_e	3.53_e	3.43_e	3.09_e	2.67_h
So_5	4.11_f	3.43_i	3.41_f	3.32_g	3.29_g	3.09_d
So_6	4.92_b	3.65_f	3.90_b	3.70_b	3.27_c	3.07_e
So_7	5.16_b	4.77_b	3.90_b	3.73_a	3.53_b	3.35_b
So_8	4.84_c	4.37_k	3.71_c	3.30_g	3.28_f	3.18_d
So_9	4.70_d	3.32_l	3.12_h	3.35_f	3.27_f	3.24_c
So_{10}	4.29_f	3.60_g	3.41_f	3.45_e	3.28_f	3.01_f
So_{11}	4.43_e	3.74_c	3.48_e	3.28_h	2.76_h	2.31_b
So_{12}	4.09_g	3.73_d	3.54_e	3.33_g	3.28_f	3.15_d
So_{13}	4.84_c	3.88_d	3.63_d	3.63_c	3.50_c	3.31_b
So_{14}	4.45_e	3.53_h	2.94_i	3.01_k	3.01	2.75_g
So_{15}	4.43_e	3.41_j	3.41_f	3.20_i	3.17_e	3.13_d
So_{16}	4.43_e	3.77_d	3.47_e	3.43_e	3.33	3.01_f
So_{17}	5.43_a	4.80_a	3.94_a	3.74_a	3.61_a	3.40_a
So_{18}	4.09_g	3.52_h	3.41_f	3.11_j	3.05_j	3.01_f
So_{19}	4.54_d	3.65_e	3.65_d	3.53_d	3.15_g	3.15_d
So_{20}	4.36_f	3.75_d	3.41_f	3.37_f	3.21_g	3.12_d
Mean	4.55	3.68	3.40	3.34	3.30	3.29

Values in the column followed by same letters not differ significantly by DMRT (p=0.05).

Results and Discussion

Survey for the incidence and severity of sheath rot incited by *S. oryzae*

The survey conducted to assess the sheath rot incidence of rice in the major rice growing areas in Nagapattinam district of Tamil Nadu revealed that the disease incidence ranged from 12.32 to 30.43 per cent showing the endemic nature of the disease Table 1. The maximum per cent disease incidence (30.43%) and severity (32.41%) was recorded in Kathiramangalam of Sirkazhi region followed by Kodankudi (29.68% disease incidence and 30.49% disease severity) of Mayiladuthurai region, Valivalam (28.48% disease incidence and 28.90% disease severity) of kilvelur region, Villiyanallur (27.50% incidence and 28.38% disease severity) and Kuthalam (26.32% disease incidence and 28.25% disease severity) of Mayiladuthurai region. The least incidence (12.32%) and severity (10.11%) was recorded in Nagoor of Nagapattinam region. In general sheath rot disease incidence was more in cultivar ADT 36 and ADT 39 compared to other cultivars.

The variation in the extent of the disease incidence might be due to the prevalence of the isolates of the pathogen differing in their virulence as observed in the present study. Similar such endemic nature of sheath rot disease of rice in Tanjavur district of Tamil Nadu was earlier reported by Syamala (2007). Also, Naing *et al*., (2008) reported 5 to 34% sheath rot disease incidence in Myanmar. Further, in Tamilnadu, all high yielding rice cultivars are found to be susceptible for sheath rot which is severe during late *kharif* season (Lewin and Vidhyasekaran, 1987). Similarly, Girish (1999) conducted survey in different locations of Karnataka and he identified sheath rot incidence ranged from 26.4 to 44.5 per cent in Bangalore area, and observed the maximum incidence in Tumkur 47.3 per cent. SowjanyaJakkuva (2012) was observed that sheath rot disease incidence ranged from 8.5 to 35.59 with highest per cent disease incidence (35.39) in Khanapur. Whereas, the per cent disease index ranged from 6.67 to 37.78. Naveen kumar and Mohanpriya (2016) was observed highest incidence sheath rot disease were found in Orathur (30.5%) village and least incidence was found in Vennakuzhi (12.1%) village in Tamilnadu. All these earlier reports corroborates with the present findings.

Growth of *S. oryzae* isolates on different solid and liquid media

Among the media tested, potato dextrose media was found to be the best in supporting the growth of *S.oryzae*asit recorded significantly the maximum mean mycelial growth (4.55cm) and mycelial dry weight of (317.34mg) followed by Czepek'sdox medium (3.68cm and 280.29 mg), Carrot extract agar medium (3.40cm and 239.36mg), Oatmeal agar medium (3.34cm and 225.44mg), Richards medium (3.30cm and 189.04mg) and Radish dextrose agar medium (3.29 cm and 176.92mg) in the decreasing order of merit.

Among the 20 isolates SO_{17} isolated from Kathiramanagalamvillage significantly recorded the highest mycelial growth (5.43 cm) and dry weight (348.16 mg) on the 15th day of observation in PDA medium. The least mycelial growth (2.31cm) and dry weight (118.76 mg) was observed in isolate SO_{11} (Thalaignayiru) in radish dextrose agar medium table 2. The present study clearly revealed that potato dextrose medium as the best suited

Table 3: Growth of *S. oryzae* isolates on different liquid media.

Isolates	Mycelial dry weight (mg)					
	PDA broth	Czepek'sDox broth	Carrot dextrose broth	Oat meal broth	Richards broth	Radish dextrose broth
So_1	284.80_e	301.47_b	257.70_d	262.84_b	242.50_b	178.74_e
So_2	179.10_g	254.00_e	240.03_e	208.46_d	163.07_c	163.07_f
So_3	298.17_d	297.17_c	233.00_e	211.26_d	207.10_b	162.73_f
So_4	320.48_b	271.11_d	265.41_c	248.41_b	206.74_b	199.01_e
So_5	277.00_e	255.53_e	217.76_f	209.03_d	185.39_b	177.53_e
So_6	296.06_d	224.01_g	210.33_f	119.20_e	180.23_c	129.07_g
So_7	255.53_f	236.57_g	244.96_d	164.84_e	154.10_c	145.37_f
So_8	333.30_b	328.41_b	300.32_b	280.45_b	240.14_b	223.00_c
So_9	254.80_f	224.80_g	181.43_g	180.63_d	160.36_c	130.46_g
So_{10}	299.46_d	270.31_d	264.73_c	242.00_c	238.70_b	184.18_d
So_{11}	321.93_b	252.50_f	237.30_e	236.56_c	219.10_b	118.76_h
So_{12}	309.20_c	309.73_b	281.76_c	269.81_b	229.40_b	212.30_c
So_{13}	266.66_e	257.46_d	227.30_e	218.41_c	197.32_b	162.73_f
So_{14}	321.03_b	262.86_d	260.96_d	181.53_d	164.00_c	155.76_f
So_{15}	327.76_b	314.53_b	307.36_b	281.76_b	229.40_b	198.87_d
So_{16}	328.48_b	310.73_b	264.10_c	264.30_b	238.48_b	232.00_b
So_{17}	348.16_a	342.66_a	318.43_a	312.36_a	303.50_a	254.80_a
So_{18}	278.78_e	263.81_d	238.88_e	228.74_c	198.48_b	177.74_e
So_{19}	253.30_f	244.96_e	189.20_g	180.29_d	148.86_c	132.00_g
So_{20}	313.40_b	252.27_f	152.87_h	140.40_e	119.10_c	119.10_h
Mean	317.34	280.29	239.36	225.44	189.04	176.92

Values in the column followed by same letters not differ significantly by DMRT (p=0.05).

Table 4: Morphological characteristics of *S. oryzae* isolates.

Isolate number	Color of mycelium	Type of mycelium	Shape of conidia	Conidial size (µm)	
				Length	Width
So_1	White cottony aerial growth	Septate hyaline and branched	Cylindrical	3.83_e	2.80_f
So_2	White cottony aerial growth	Septate hyaline and branched	Cylindrical	3.24_k	2.63_j
So_3	White cottony aerial growth	Septate hyaline and branched	Cylindrical	4.02_c	2.48_m
So_4	White cottony aerial growth	Septate hyaline and branched	Cylindrical	3.18_l	2.74_h
So_5	White cottony aerial growth	Septate hyaline and branched	Cylindrical	3.06_m	2.81_e
So_6	White cottony aerial growth	Septate hyaline and branched	Cylindrical	3.78_f	2.60_k
So_7	White cottony aerial growth	Septate hyaline and branched	Cylindrical	4.00_c	2.90_c
So_8	White cottony aerial growth	Septate hyaline and branched	Cylindrical	4.21_e	3.00_b
So_9	White cottony aerial growth	Septate hyaline and branched	Cylindrical	3.50_i	2.71_i
So_{10}	White cottony aerial growth	Septate hyaline and branched	Cylindrical	3.90_e	3.00_b
So_{11}	White cottony aerial growth	Septate hyaline and branched	Cylindrical	3.00_m	2.32_n
So_{12}	White cottony aerial growth	Septate hyaline and branched	Cylindrical	3.23_k	2.23_k
So_{13}	White cottony aerial growth	Septate hyaline and branched	Cylindrical	4.09_c	2.85_c
So_{14}	White cottony aerial growth	Septate hyaline and branched	Cylindrical	3.53_h	2.74_h
So_{15}	White cottony aerial growth	Septate hyaline and branched	Cylindrical	3.63_g	2.60_k
So_{16}	White cottony aerial growth	Septate hyaline and branched	Cylindrical	4.01_d	2.89_d
So_{17}	White cottony aerial growth	Septate hyaline and branched	Cylindrical	4.31_a	3.01_a
So_{18}	White cottony aerial growth	Septate hyaline and branched	Cylindrical	3.4_i	2.75_g
So_{19}	White cottony aerial growth	Septate hyaline and branched	Cylindrical	3.30_j	2.58_l
So_{20}	White cottony aerial growth	Septate hyaline and branched	Cylindrical	3.20_k	2.51_m

Values in the column followed by same letters not differ significantly by DMRT (p=0.05).

for the growth of *S. oryzae* while radish dextrose agar medium was the, (2015) were reported that potato dextrose agar medium least suited for the growth of the pathogen. Similar to the present observations Sethuraman (2003) and Venkatesha (2015) as the best for the growth of *S.oryzae*. Also, Sunilkumar and Patibanda (2017) and Sharma *et al.,* (2018) reported that potato dextrose agar medium influenced for the best growth of *S.oryae*. The present investigation was contradictory to Sowjanya Jakkuva (2012) who reported that oat meal agar medium was best in supporting the growth of *S.oryzae* with maximum radial growth (5.73cm) and mycelial dry weight (361.67mg). Also, such variation on growth of *S. oryzae* in different media was reported by earlier workers (Pandiarajakumar, 1992; Radhika, 1994; Vijayakumar, 1998; Syamala, 2007). All these earlier reports corroborate with the present findings.

Morphological characteristics of *S. oryzae* isolates

With regard to the morphology, the fungus produced white fluffy growth with orange ochre tinge on the reverse of the PDA culture plate with septate, hyaline and branched mycelium, branched and hyaline conidiophores with hyaline, smooth, single celled and cylindrical conidia established in all the 20 isolates.

The above characters were in agreement with those of the original descriptions given by Ou (1972) and Gams and Hawksworth (1975). However, among the isolates, isolate SO_{17} produced conidia with significantly maximum length (4.31mm) and width (3.01mm). The isolate SO_{11} recorded minimum length (3.00mm) and width (2.32mm) of conidia (Table 4). Similar such variations in the conidial length and width were also reported (Radhika, 1994; Sethuraman, 2003; Syamala, 2007; Giraldo *et al.,* 2015; Painkra, 2016).

Effect of inoculation methods on sheath rot incidence (Pot culture)

Further, in the present study grain inoculation technique resulted in significantly the highest per cent disease incidence and tillers infected (57.21 and 92.10%) than other methods which was followed by sheath inoculation method (51.62 and 74.05%) and spore suspension method (38.47 and 53.05%) respectively. Several workers (Estrada *et al.,* 1979; Raina and Singh, 1980; Raju and Singh, 1981) have studied the efficacy of different methods of inoculation and reported the superiority of insertion of rice/pearl millet grain culture into the flag leaf sheath over other methods. Although, Kang and Rattan (1983) reported the development of

Table 5: Effect of inoculation methods on sheath rot incidence (Pot culture).

Sl. No	Method of inoculation	No. of tillers Infected	Percentage of tillers infected	Per cent Disease Incidence (PDI)
1.	Grain inoculation	18.42[a]	92.10	57.21[a]
2.	Sheath inoculation	14.81[b]	74.05	51.62[b]
3.	Spore suspension method	16.61[c]	53.05	38.47[c]

Values in the column followed by same letters not differ significantly by DMRT (p=0.05).

Table 6: Pathogenecity of *S. oryzae* isolates (Pot culture).

S. oryzae isolates	Per cent Disease incidence (PDI)	Lesion size (mm)	
		Length	width
So_1	50.25[j]	31.11[n]	4.81[j]
So_2	52.45[f]	33.62[l]	4.39[n]
So_3	44.36[q]	33.01[m]	5.00[f]
So_4	52.72[e]	36.01[g]	4.89[g]
So_5	51.81[h]	34.34[j]	4.83[i]
So_6	53.90[d]	36.40[e]	4.36[p]
So_7	47.45[n]	35.42h	5.04[d]
So_8	55.64[b]	38.63[b]	5.28[b]
So_9	51.20[i]	37.00[d]	4.53[m]
So_{10}	54.33[c]	37.82[c]	5.24[c]
So_{11}	43.31[r]	30.91[o]	3.20[s]
So_{12}	48.64[l]	31.14[n]	5.01[e]
So_{13}	49.81[k]	36.16[fg]	3.91[r]
So_{14}	50.22[j]	33.71k[l]	4.67[l]
So_{15}	45.55[o]	33.11[m]	4.86[h]
So_{16}	44.72[p]	36.30[ef]	4.68[k]
So_{17}	58.33[a]	39.40[a]	5.31[a]
So_{18}	52.11[g]	35.01[i]	4.20[p]
So_{19}	44.60[p]	33.83[k]	4.38[o]
So_{20}	48.42[m]	36.31[ef]	4.23[q]

Values in the column followed by same letters not differ significantly by DMRT (p=0.05).

disease symptoms with injection or insertion of mycelial cum spore suspension from PDA culture, insertion of grain culture inoculums seems to be the most feasible method as it produced sheath rot diseased lesions which would facilitate better scoring. Saravanakumar *et al.,* (2009) also opined that the artificial inoculation method *viz.,* grain culture technique was the best method for better disease scoring. Selvaraj and Annamalai (2015) observed that high infection frequency of *S. oryzae* inoculated by standard grain inoculum technique than other methods. However, the spore suspension method was also reported to cause highest per cent disease incidence than grain culture technique (Narayanaprasad *et al.,* 2011).

Pathogenicity of *S. oryzae* isolates (Pot culture)

The results of the pot culture experiment conducted by artificial inoculation of the pathogen revealed varied levels of pathogenicity with different isolates. Among the isolates of *S. oryzae* collected from different conventionally rice growing areas of Nagapattinam district, the isolate collected from Kathiramangalam (SO_{17}) village was found as the most virulent which recorded maximum per cent disease incidence (58.33%) with maximum lesion size 39.40 mm length and 5.31 mm width on rice variety ADT 39 which was followed by SO_8 with a PDI of 55.64 per cent and lesion size of 38.63 (length) and 5.28 mm (width) and SO_{10} with a PDI of 54.33% and lesion size of 37.82 and 5.24 mm. The least PDI (43.31%) and lesion size (30.91 and 3.20mm) was recorded with isolate SO_{11} Table 6. The variations in sheath rot incidence in different locations could be well attributed to the difference in virulence of the *S. oryzae* isolates prevalent in the respective areas.

In a similar study, Radhika (1994) reported that the isolates collected from Madurai and Athur were highly virulent but the isolate collected from Udaikulam of Ramanathapuram district were less virulent. Likewise, Vijayakumar (1998) found that isolate collected from Trichy, the rice belt of Tamil Nadu was the most virulent and that from Thuthukudi (where rice is not the major crop) was the least virulent. Sethuraman (2003) reported that isolate collected from AC&RI, Madurai produced maximum lesion size. Syamala (2007) also reported that isolate collected from Thanjavur, the rice belt of Tamil Nadu was the most virulent and that from Karur was the least virulent. Similarly, Sunilkumar and Patibanda (2017) reported that high pathogenic nature of isolate SO-NDP with 1.5cm lesion length collected from naidupeta, Nellore district, Andhra Pradesh. All these earlier reports corroborate and lend support to the present findings.

References

Ainsworth, G.C. (1961). Dictionary of fungi. Commonwealth Mycological Institute, Fenslane, Kew, Surrey, England. 547.

Anonymous (2012).www.knowledgebank.irri.org/ Ricedoctor/ information-sheets- mainmenu-2730/diseases-mainmenu-2735/sheathrot-mainmenu-771.html.

Bigirmana, V., G.K.H. Hua, O.I. Nyamangyoku and M. Hofte (2015). Rice sheath rot: An emerging Ubiquitous Destructive Disease Complex. *Frontiers in Plant science*, **6:** 1066.

Booth, C. (1971). Fungal culture media. In: Methods in Microbiology. *Academic press*, New York, **4**: 49

CMI (1980). Common wealth Mycological Institute. *Sarocladium oryzae.* CM1 Descriptions of pathogenic

Fungi and Bacteria. No. 673. Common wealth Mycological Institute, Fenslane, Kew, Surrey, England.

DecockCrous, P.W. and J. Guarr (2015). Phylogeny of Sarocladium (Hypocreales). *Persoonia,* **34:** 10–24

Estrada, B.A., L.M. Sanchez and J.P. Crill (1979). Evaluation of screening methods sheath rot resistance of rice. *Pl. Dis. Reptr*, **63:** 908-911.

Fahmy (1923). The production by *Fusariumsolani*of toxic excretory substance capable of causing wilting of plants. *Phytopathology*, **13:** 543-550.

FAOSTAT (2013). Food and Agriculture Organisation Statistics. [Online]. Available by http:/ FAO/www.fao.org

Giraldo, A., J. Gené, D.A. Sutton, H. Madrid, G.S. de Hoog and J. Cano.

Kang, M.S. and G.S. Rattan (1983). Sheath rot in the Punjab, India. Internationaljournal on rice. *Res. Newsl.*, **4(3):**14-15.

Lewin, H.D. and P. Vidhyasekaran (1987). Controlling sheath rot (ShR) in rice. *Int. Rice Res. Newsl.*, **12(1):**17.

Naing, T.A.A., A.J. Kingsbury, A. Buerkertand and M.R. Finckh (2008). A Survey of Myanmar Rice Production and Constraints. *J. Agric. Rural Development in the Tropics and Subtropics* Volume, **109(2):** 151–168.

Narayanaprasad, N., B.R. Jagadeesh, K.G.B. Shiva, P.S. Prasad, G.K. Sudarshan and K.N. Sunil (2011). Studies on the nature and properties of sheath rot (Sarocladium oryzae Sawada) causing seed borne pathogen on rice. International. *Journal of Science and Nature*, **2(2):** 317-320.

Naveenkumar, R. and R.Mohanapriya (2016). Survey and evaluation of efficacy of some fungicides against virulence of Sarocladium oryzae inciting sheath rot disease of rice. *Oryzae – An international Journal of Rice*, **53(4):** 464-469.

Naveenkumar, R. and R. Mohanpriya (2016). Survey and evaluvation of effiecacy of some fungicides against varience of *Sarocladium oryzae* inciting Sheath rot disease of rice. *International journal on rice,* **53(4):** 464-469.

Painkra, D.K. (2016). A study on management of sheath rot disease of rice caused by *Sarocladium oryzae* (Sawada) Games and Hawksworth. *MSc., thesis*, Department of Plant Pathology. Indira Gandhi KrishiVishwavidyalaya, Raipur.

Pandey, K. and Vishwakarma (1998). Growth, sporulation and colony characters of *Alternariaalternata*on different vegetable- based media. *Indian J. Mycol. Pl. Pathol.*, **28:** 346-347.

Pandiyarajakumar, S. (1992). Studies on sheath rot of rice caused by *S. oryzae*. *M.Sc., (Ag.) Thesis*, Tamil Nadu Agricultural University. Coimbatore, India, pp.67.

Radhika, N. (1994). Studies on sheath rot of rice (*Oryzasativa*L.) caused by *Sarocladium oryzae*(Sawada) W. Gams and D.Hawksw**.** *M.Sc.(Ag.) Thesis*, Tamil Nadu Agricultural University, Coimbatore, India. 192p.

Raina, L. and G. Singh (1980). Sheath rot outbreak in the Punjab. *Int. Rice. Res. Newsl.*, **5(1):**16.

Raju, C.A. and R.A. Singh (1981). Studies on sheath rot on rice. *International journal of rice Res. Newsl.,* **6(2):**11.

Rangaswami, G. (1972). N. Diseases of Crop Plants in India. Prentice Hall of India Pvt. Ltd., New Delhi. 520p.

Sakthivel, N. and S.S. Gnanamanickam (1987). Evaluation of *Pseudomonas fluorescens*for suppression of sheath rot disease and for enhancement of grain yields in rice, *Oryza sativa*, L. *Applied Environmental Microbiology,* **53(1):** 2056-2059.

Saravanakumar, D., N.Lavanya, K.Muthumeena, T. Raguchander and R. Samiyappan (2009). Fluorescent pseudomonad mixtures mediate disease resistance in rice plants against sheath rot (*Sarocladium oryzae*) disease. *Biocontrol.,* **54 (2):** 273–286.

Selvaraj and Annamalai (2015). In vitro antagonism of indigenous *Trichoderma* isolates against phytopathogen causing sheath rot disease in paddy, **4(4) :** 429-437.

Sethuraman, K. (2003). Management of rice sheath rot by non chemical methods *Ph.D. Thesis*, Agricultural College and Research Institute, Madurai. TNAU. Coimbatore. 16-79.

Sharma, L., K.K. Sharma and A.P. Sinha (2018). Molecular characterization of *Sarocladium oryzae* through RAPD technique: causal agent of sheath rot disease of rice. *Ann. OfPl. Protec. Scie.*, **26 (1):** 91-97.

SoujanyaJakkuva (2012). Studies on sheath rot of rice caused by *Sarocladium oryzae*(Sawada) Gams and Hawksworth. *MSc., thesis*, Department of Plant Pathology college of Agriculture, Dharwad University of Agricultural Sciences, Dharwad – 580 005

Sunil kumar, Y. and A.K. Patibanda (2017). Variability Among the isolates of *Sarocladium oryzae*incitant of Rice Sheath Rot. *Int. J. Pure App.Biosci.,* **5 (6):** 1528-1537.

Syamala, S. (2007). Studies on the management of paddy sheath rot. *M.Sc., (Ag.). Plant Pathology Thesis*, Tamil Nadu Agricultural University. Coimbatore, India, pp.67.

Venkatesha, M.G. (2015). Morpho - molecular characterization of diversity in Sarocladium oryzae causing sheath rot in paddy. *MSc., thesis*, Division of Seed Science and Technology Indian Agricultural Research Institute, New Delhi – 110012, India.

Vijayakumar, D. (1998). Studies on the management of paddy sheath rot. *M.Sc., (Ag.) Plant Pathology Thesis*, Tamil Nadu Agricultural University. Coimbatore, India, pp.67.

Vincent de Bigirimana., Gia KH Hua., ObediNyamangyoku., M. Hofte (2015). Rice sheath rot : an emerging ubiquitous destructive disease complex. *Frontiers in plant science,* **6 :** 1066.

Vivekananthan, R., R. Sudhagar, M. Ravi, T. Ganapathy, K. Thiyagarajan and R. Rabindran (2005). Evaluation of relative resistance of rice against sheath rot through combined screening techniques. *ActaPhytopathol. Entomol. Hung*, **40(3–4):** 279–287.

Yesuraja, I. (2001). Management of rice sheath rot caused by *Sarocladium oryzae* (Sawada) W. Gams and D. Hawksw. *PhD. Thesis*, Agricultural College and Research Institute, Madurai.