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Morphological Variability Analysis of *Rhizoctonia solani* Isolates Causing Sheath Blight of Rice

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A B S T R A C T

Over half of the world's population depends on rice for their primary food supply. In 2020, 164.19 million hectares of rice were cultivated worldwide, with an annual yield of 756.74 million tons. In India, which is the world's second-largest producer and consumer with an area of 45.00 million hectares and a projected production of 178.30 million tonnes in 2020, rice cultivation is the backbone of the agricultural economy. There are several constraints in the production of rice of which diseases caused by fungi are responsible for major economic losses. Rice is mostly challenged by blast, sheath blight, brown spot, grain discolouration etc. Sheath blight caused by *Rhizoctonia solani* is a destructive disease in rice and is considered world's significant disease, second most predominant after blast disease and may reduce yield by 45%. The present study was carried out at Wadura (J & K) in the Faculty of Agriculture, Division of Plant Pathology (SKUAST–K) during 2022 and 2023. In this study, the morphological variations in the population of *R. solani* were examined. Fifty isolates were obtained from various rice-growing districts in Kashmir. The pathogen was identified using morphological traits; the morphological characters of *Rhizoctonia solani* were examined based on colony colour, growth pattern and hyphal width. There was a great deal of variation among these *R. solani* isolates.

Introduction

Over half of the world's population depends on rice for their primary food supply. In 2020, 164.19 million hectares of rice were cultivated worldwide, with an annual yield of 756.74 million tons. In India, which is the world's second-largest producer and consumer with an area of 45.00 million hectares and a projected production

of 178.30 million tonnes in 2020, rice cultivation is the backbone of the agricultural economy (FAOSTAT, 2022). The demand for rice is expected to exceed 800 million metric tons by the end of 2025. By 2050, sustainable production must double in order to feed the world's population of almost 9 billion people.

In Jammu and Kashmir rice is grown from times immemorial and stands as the staple food of the union territory. The total rice area of the union territory is 280.51 thousand hectares with production of 587.4 thousand tonnes (Digest of Statistics, 2020).

There are several constraints in the production of rice of which diseases caused by fungi are responsible for major economic losses. Rice is mostly challenged by blast, sheath blight, brown spot, grain discolouration etc. Sheath blight caused by *Rhizoctonia solani* is a destructive disease in rice and is considered world's significant disease, second most predominant after blast disease (Molla *et al.,* 2020). It may reduce yield by 45% (Margani *et al.,* 2018). Morphological variations are common in many fungal pathogens.

The initial step to understand population structure is evaluation of morphological variability among pathogen isolates. The knowledge on variability of a pathogen is considered to be an important aspect for disease management especially for development of area specific resistant cultivars. Therefore, this study was undertaken to establish morphological variations among *Rhizoctonia solani* isolates infecting crops in diverse zones of the J&K.

Materials and Methods

In 2022, rice plants with typical sheath blight symptoms were collected from various rice grown districts of Kashmir, i.e. Anantnag, Bandipora, Baramulla, Budgam, Ganderbal, Kulgam, Kupwara and Pulwama. Further studies were carried out at Wadura (J & K) in the Faculty of Agriculture, Division of Plant Pathology (SKUAST–K) during 2022 and 2023. 50 isolates were isolated from Sheath blight samples and using the hyphal tip approach (Burgess *et al.,* 2008), pure cultures were obtained, and they were recognized using the Sneh *et al.,* (1991) key.

For further study, stock cultures were maintained at 4^0C on PDA slants. *R. solani* isolates were sub-cultured on 90 mm Petri plates with PDA medium and their morphological characteristics were investigated. The culture colour and mycelial growth type (scarce, aerial mycelium does not obscure surface mycelium; abundant, aerial mycelium obscures surface mycelium and touches the Petri plate cover; moderate, aerial mycelium obscures surface mycelium but does not touch the Petri plate cover) were noted. Every 24 hours, the colony growth rate was noted until the Petriplates were fully colonized. The difference in radial growth between ratings was used to compute the colony growth rate each day. After 15 days, morphological parameters such as mycelial colour, hyphal width, etc. were recorded in cultures at 28 ± 2^0C for each of the 50 isolates (Panja *et al.,* 2011). The growth pattern was observed seven days after inoculation. To find the average hyphal width, micrometry was done using a calibrated compound microscope aided by Magvision software.

Results and Discussion

50 isolates were isolated in the current investigation to examine variability. Through microscopic examination, it was possible to identify three unique traits shared by all 50 *R. solani* isolates in this study: hyphal branching at a right angle, constriction at the mycelium's site of branching, and the presence of a septum near the branching junction. These traits are highly significant from a taxonomical perspective (Sneh *et al.,* 1991).

All isolates were divided into three groups based on the colour of their cultures. Out of 50 isolates, light brown was the most prevalent colour, accounting for 41 of them followed by six Dark brown and three white isolates Table 1. There was no correlation found between colour and the pathogenicity of the isolates. The primary cause of the growth media's discolorations is the pathogen generation of pigments. The quantity of pigments released by each isolate in the media may also be correlated with variations in colour intensity.

These findings are in line with the previous study conducted by Kipsumbai *et al.,* (2022). The isolates were divided into three groups based on their growth patterns. Table 1 indicates that of the isolates, 16 had abundant growth, 13 had moderate growth, and 21 had only scarce growth. Lal and colleagues (2014) also documented these three growth patterns. A correlation was shown by Tu (1967) and Akai *et al.,* (1960) between aerial mycelium growths and virulence pattern. In contrast to the latter, who discovered that strains with low mycelium growth were less pathogenic, the former found that strains with less aerial mycelium were more virulent.

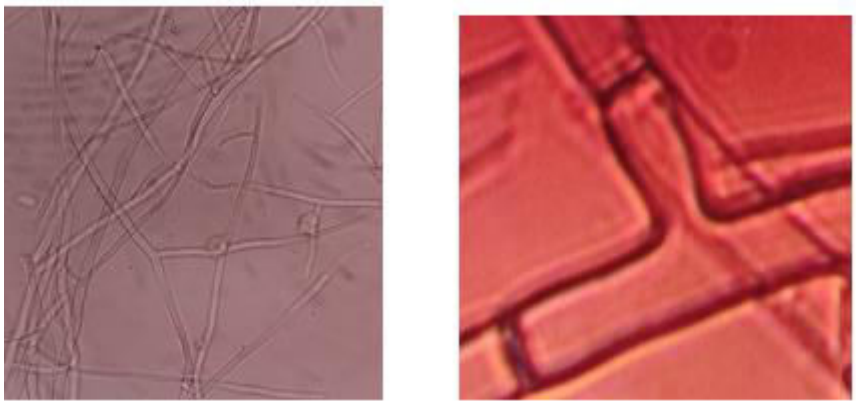
Table.1 Morphological characteristics of various rice isolates of *R. solani*

S. No.	Isolate Name	Place of collection	Radial growth (mm/day)	Hypha colour	Hyphal Width (micrometer)	Growth pattern	Colony Colour	Circular pattern
1	R-Ac	Achabal, Anantnag	25.50	Hyaline	7.34	Abundant	Light brown	Absent
2	R-Km	Kamad, Anantnag	27.00	Hyaline	8.83	Abundant	Dark brown	Absent
3	R-Sd	Sandoo, Anantnag	16.00	Hyaline	7.43	Abundant	Light brown	Absent
4	R-Dg	Devalgam, Anantnag	11.50	Hyaline	8.76	Moderate	White	Absent
5	R-Ln	Larnoo, Anantnag	13.00	Hyaline	7.06	Moderate	Light brown	Absent
6	R-Sg	Sagam, Anantnag	6.70	Hyaline	5.22	Scarce	Light brown	Present
7	R-Rp	Renipora, Anantnag	6.10	Hyaline	4.96	Scarce	Light brown	Absent
8	R-Sh	Shangus, Anantnag	8.50	Hyaline	6.83	Scarce	Light brown	Present
9	R-Vg	Vagam, Anantnag	7.50	Hyaline	6.27	Scarce	Light brown	Absent
10	R-Bb1	Bijbehara, Anantnag	11.70	Hyaline	8.42	Scarce	Light brown	Absent
11	R-Bb2	Bijbehara, Anantnag	17.50	Hyaline	9.15	Scarce	Light brown	Absent
12	R-Qm	Quilmuqam, Bandipora	11.00	Hyaline	8.24	Moderate	Light brown	Absent
13	R-Ns	Nesbal, Bandipora	11.50	Hyaline	7.98	Abundant	Light brown	Absent
14	R-Dl	Delina, Baramulla	7.40	Hyaline	6.42	Scarce	Light brown	Present
15	R-Ch	Chakla, Baramulla	6.30	Hyaline	5.15	Scarce	Dark brown	Present
16	R-Jm	Jahama, Baramulla	6.80	Hyaline	6.05	Moderate	Light brown	Absent
17	R-Hj	Hanjivera, Baramulla	9.50	Hyaline	8.05	Scarce	Light brown	Absent
18	R-Nh	Nehalpora, Baramulla	8.20	Hyaline	7.34	Moderate	Light brown	Absent
19	R-Pl	Palhallan, Baramulla	7.90	Hyaline	8.27	Moderate	Light brown	Absent
20	R-Nt	Nathipora, Baramulla	11.00	Hyaline	8.60	Scarce	Light brown	Absent
21	R-Sl	Seeloo, Baramulla	12.70	Hyaline	7.25	Scarce	Light brown	Absent
22	R-Wd	Wadura, Baramulla	15.50	Hyaline	5.43	Moderate	Light brown	Absent

23	R-Ag	Azadgunj, Baramulla	8.30	Hyaline	6.27	Moderate	Light brown	Absent
24	R-Kn	Kanispora, Baramulla	10.70	Hyaline	7.50	Scarce	Dark brown	Present
25	R-Dh	Durhama, Baramulla	6.50	Hyaline	6.99	Scarce	Light Brown	Present
26	R-Wg	Wagura, Baramulla	7.30	Hyaline	6.50	Moderate	Light brown	Present
27	R-Wn	Wussan, Baramulla	7.20	Hyaline	6.72	Abundant	Light brown	Absent
28	R-Bp	Batpora, Budgam	24.00	Hyaline	8.86	Abundant	Light brown	Absent
29	R-Mg	Magam, Budgam	15.30	Hyaline	8.40	Abundant	Dark brown	Absent
30	R-Wp	Waripora, Budgam	22.90	Hyaline	7.89	Abundant	Light brown	Absent
31	R-Ar	Aarath, Budgam	15.40	Hyaline	9.15	Moderate	Dark brown	Present
32	R-Rz	Razwan, Budgam	14.00	Hyaline	6.72	Abundant	Light brown	Absent
33	R-Nr	Narbal, Budgam	13.30	Hyaline	7.69	Scarce	Light brown	Absent
34	R-Cb	Chatbugh, Budgam	26.30	Hyaline	9.33	Scarce	Light brown	Absent
35	R-Ng	Nadigam, Budgam	9.60	Hyaline	7.95	Scarce	Light brown	Absent
36	R-Ww	Wadwan, Budgam	14.00	Hyaline	8.42	Abundant	Light brown	Absent
37	R-Bd	Badipora, Budgam	11.30	Hyaline	7.81	Scarce	Light brown	Absent
38	R-Sp	Safapora, Ganderbal	9.30	Hyaline	9.55	Abundant	Light brown	Absent
39	R-Tl	Tullamulla, Ganderbal	11.30	Hyaline	8.06	Abundant	Light brown	Absent
40	R-Dd	Duderhama, Ganderbal	17.50	Hyaline	7.34	Moderate	Light brown	Absent
41	R-Kg	Kangan, Ganderbal	23.50	Hyaline	9.13	Scarce	White	Absent
42	R-Bs	Barsoo, Ganderbal	12.00	Hyaline	8.68	Abundant	Light brown	Absent
43	R-La	Lar, Ganderbal	21.60	Hyaline	8.97	Abundant	Light brown	Absent
44	R-Dn	Danow, Kulgam	16.00	Hyaline	7.18	Abundant	Light brown	Absent
45	R-Kl	Kilam, Kulgam	12.50	Hyaline	7.88	Moderate	Light brown	Absent
46	R-Mp	Malpora, Kulgam	8.70	Hyaline	6.38	Scarce	Light brown	Absent

47	R-Lg	Langate, Kupwara	9.20	Hyaline	8.24	Scarce	Dark brown	Present
48	R-Yn	Yunisoo, kupwara	24.30	Hyaline	8.98	Abundant	White	Present
49	R-Wh	Wahipora, Kupwara	9.40	Hyaline	8.25	Scarce	Light brown	Absent
50	R-Na	Naira, Pulwama	9.80	Hyaline	7.59	Moderate	Light brown	Absent

Figure.1 *Rhizoctonia solani* mycelium with right angled branching and constriction



In the present study also R-Cb and R-Kg having less aerial mycelium growth were more virulent. But also, R-Wn and R-Sp were found more virulent even though they had more aerial growth of mycelium. Eight isolates met fast category for radial growth rate (>18 mm/day) (Table 1). A medium radial growth rate (> 12–18 mm/day) was shown by 13 isolates.

A slow radial growth rate (< 12 mm/day) was observed in 29 isolates. Compared to slow growing isolates, fast and medium growing isolates were more pathogenic. While Wamishe *et al.,* (2007) stated that an isolate's aggressiveness could be predicted based on its growth rate on a Petri plate, Basu *et al.,* (2004) discovered no association between an isolate's mycelial growth and its virulence on the host. In every isolate, the hypha was hyaline and varied in width from 4.96 to 9.55 micrometers.

Author Contributions

Zarka Nabi: Investigation, formal analysis, writing—original draft. T. A. Wani: Validation, methodology, writing—reviewing. F. A. Bhat:—Formal analysis, writing—review and editing. Ali Anwar: Investigation, writing—reviewing. Mahreena Farooq: Resources, investigation writing—reviewing. Tahir A. Sheikh: Validation, formal analysis, writing—reviewing. Fehim Jeelani Wani: Conceptualization, methodology, data curation, supervision, writing—reviewing the final version of the manuscript. Angrej Ali: Investigation, formal analysis, writing—original draft. Zohra Shabir: Validation, methodology, writing—reviewing. Ishan Ahmad Dar:—Formal analysis, writing—review and editing. Farooq Ah Ahanger: Investigation, writing—reviewing.

Data Availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethical Approval Not applicable.

Consent to Participate Not applicable.

Consent to Publish Not applicable.

Conflict of Interest The authors declare no competing interests.

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