Survey and incidence of rice sheath blight in major rice growing areas of eastern Uttar Pradesh

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Abstract

Rice (Oryza sativa L.) being a staple food crop of India, play important role in the food security system. The crop is an important integral part of Indian dietary and staple food of more than 60% and its cultivation has spread too many parts of the world due to its versatility (Koutr and Rao, 2008; Mishra et al., 2005)[6, 9]. Both China and India are the largest rice producing countries in world, jointly they account for 51.4% of the global rice production. In India, nearly 112.9 million tonnes of rice are grown in 43.5 million hectares with the productivity of 2578 kg/ha. West Bengal is the largest rice producing state in India, and it has 5.82 million ha under rice cultivation, which covers irrigated and rainfed areas with a production of 14.97 million tonnes and productivity of 2.6 tonnes/ha. While in Uttar Pradesh State it is grown in 5.6 million ha, producing 13.28 million tonnes with average productivity of 2 tonnes/ha (2017-18) (www.indiastat.com).

Moreover, the production and productivity of rice is influenced by several abiotic and biotic factors that causes yield losses of up to 45% (Margar and widadi 2018) [8]. Among all the biotic stresses, the fungal diseases in rice are most predominant throughout the world (Asibi et al., 2019) [1]. The productivity of rice is affected by several pathogens (Margar and widadi 2018) [8], of which sheath blight (ShB) disease of rice caused by Rhizoctonia solani Kuhn is one of the destructive pathogen causing disease in rice and considered as world’s significant disease, second most predominant to the blast disease (Zheng et al., 2013; Molla et al., 2020) [15]. The ability of pathogen to survive in soil and plant debris enables them to survive in various ways and makes it difficult to fight disease (Kumar et al., 2009) [7]. It has become more prevalent in most of the improved varieties currently growing in India (Prakasam et al., 2013) [12]. The spread of disease has extensively increase in terms of both occurrence and intensity over last few decades (Yellareddy et al., 2014) [14]. Currently, it is one of the major production limitations in the states of Eastern Uttar Pradesh, Chhattisgarh, Punjab, Odisha, Uttarakhand, Bihar, West Bengal, Haryana, coastal areas of Andhra Pradesh, Tamil Nadu, Kerala and parts of Karnataka (Prakasam et al., 2013) [12]. Study on occurrence of disease in an area can offer an idea on current status of the disease in the various growing zones which is prerequisite to take decision regarding management practices of different diseases (Gangopdhayay and Chakrabart 1982) [3].
Therefore, present survey was led in major rice growing regions of Eastern U.P to know the incidence and severity of sheath blight in various agro-ecosystems, cropping systems, rice varieties, agronomic practices and management methods in the condition that is a prerequisite to take decision on sustainable disease management practices.

2. Methods and Materials

2.1. Collection of sheath blight samples

During Kharif 2019, a sample survey was conducted in various parts of Eastern Uttar Pradesh to collect sheath blight infected rice samples for diversity studies in *R. solani*. Hence, a roving survey was carried out in five major rice-growing districts viz., Varanasi, Mirzapur, Prayagraj, Chandauli, and Jaunpur that were selected to collect the infected rice sheath blight samples for the study of variation within *R. solani* AG-1 IA (Table 1). From each village randomly 3-5 rice fields were selected when the crop was at tillering to maturity stage. Three plots in each field having an area of one square meter were selected randomly. Data was also collected on stage of the crop, disease severity and incidence in these areas. A sample often consisted of single rice tiller, which either had sheath blight lesion on the sheath/pseudo stem, or the leaves, or both. Symptoms on rice sheaths, leaves and sign (sclerotia) on the disease isolate at each observation during the survey are documented. In addition, information like plant characters and geographical location (longitude/latitude) were compiled.

Disease incidence (DI) was recorded by using the following formula

\[
\text{Disease incidence} = \frac{(\text{Number of infected tillers})}{(\text{Total number of tillers})} \times 100
\]

2.2. Isolation and purification of *Rhizoctonia solani*

Forty-five isolates were brought to the laboratory and washed under running water to remove dirt particles. Infected plant tissues are cut into small bits (~0.5 cm), surface sterilized with 1% sodium hypochlorite solution for 30 seconds and were rinsed three times with sterile distilled water and blotted dry. Hyphal tips of each isolate were transferred to an isolation medium i.e., 2 per cent water agar and incubated at 26 ± 2 °C. After 2-3 days cultures were examined microscopically for morphological characters typical of *R. solani*. Hyphal tips of each isolate which growing out from the infected plant tissue are sub-cultured on fresh potato dextrose agar (PDA) plates and incubated at 26 ± 2 °C for further purification. Following pure cultures of collected isolates were placed at 4°C for short term storage. The growth of mycelium in culture plates was documented for every 24 hours.

From each district five to ten rice growing villages and randomly 3-5 rice field having crop at the stage of tillering to maturity are selected. All the isolates were recognized as *Rhizoctonia solani* based on the right angle branching by microscopic observation. Koch’s postulates were proved for all isolates under field conditions during kharif -2019 by using mycelial bit inoculation method.

2.3. Data analysis

The relative lesion height (RLH) (cm) was calculated for per tiller, by formula given by Sharma *et al.* (1990)\[^{13}\].

\[
\text{RLH} = \frac{\text{maximum height at which lesion appear}}{\text{plant height}} \times 100
\]

The Percentage Disease Index (PDI) was calculated by ranking the RLH on a 0-9 scale of Standard Evaluation System (SES) which gives a measure of disease severity of each tiller.

**Disease severity rating scale:** (Source: IRRI, 2014)\[^{9}\]

0 = No infection
1 = lesion limited to the lower 20% of plant height
3 = lesion limited to the lower 20-30% of the plant height
5 = lesion limited to the lower 31- 45% of the plant height
7 = lesion limited to the lower 46- 65% of the plant height
9 = lesion more than 65% of the plant height

3. Results and Discussion

During the year of survey in rice growing regions of Eastern U.P. insect pests and diseases were the main biotic stresses causing significant losses to the rice production. Blast, bacterial leaf blight, brown spot, sheath blight and blast are the major diseases of rice in Eastern U.P. Sheath blight is a serious problem in high rainfall areas of eastern U.P. The disease is mostly predominant in areas where the relative humidity is very high (> 95%), the temperature is moderate (28-32°C) and high nitrogen inputs.

The data presented in the Table. 1 revealed that the per cent disease incidence (PDI) of all isolates ranged from 20% to 80% and assembled as four groups such as very high (>50), high (31-50%), moderate (20 to 30%) and low (<20%). Very high incidence noticed at paddy field of sadalpura (80%) followed by Cholapur (70%), Naini (70%) and Satahara (70), Puari kala (60), SHUATS (college field) (60). High per cent disease incidence recorded at BHU (college field) (50), Chunar (45), Kailalah (40) and jamalpur (40), moderate per cent incidence was observed at Wazidpur (35), Bakia bad (30), Dhara (30), Bichhiya khurd (25), Narayanpur (20), Maudli (20) and none of the locations were recorded as low per cent disease incidence (<20). Among 25 locations, 36% showed very high incidence (>50), 28% location showed high per cent incidence (31-49) and 36 per cent location showed moderate per cent incidence (20-30) (Fig. 1).

Disease severity of collected samples of rice sheath blight ranged from 3 to 9 score (SES Scale). Very high severity (9 scale) was observed at Sadalpura, Satahara, Naini, Cholapur. High disease severity (7 scale) recorded at Kailalah, Chunar, Jamalpur, BHU, Khajuri, Ganga kwhaja, Dhanuha, SHUATS, Saidanpur, Kalichabad, and Puari kala. While moderate disease severity (5 scale) noticed at Bichhiya khurd, Dhara, Phaphamau, Dandupur and Meerganj. Low disease severity (3 scale) recorded at Bakia bad, Narayanpur, Maudli, Aliningar, and Wazidpur. Among all the locations 16% (4) showed >65% lesion height (9 score), 44% (11 locations) recorded 46-65% lesion height (7 score), 20% (5) depicted 31-45% lesion height (5 score), 20% (5) showed 21-30% lesion height (3 score).

When the district averages were taken into account, the disease incidence (%) was found highest in Jaunpur with 48.3%, followed by Varanasi (45%), Prayagraj (45%), Chandauli (43%) and comparatively low in Mirzapur (35%). These results were in accordance with the findings of Deepak *et al.*, (2018)\[^{2}\] where they observed highest percent disease incidence of 52.5% at Nalgonda district and recorded least per cent disease incidence of 20% in Rangareddy district at Telangana. However, the correlation between crop stages and percent disease incidence and/or disease severity was not detected. Similarly, Parshuram *et al.*, (2017)\[^{11}\] surveyed in major rice growing areas of Chhattisgarh state for incidence
and spread of rice sheath blight and reported that Gariyaband district recorded highest mean of incidence 76% and Durg recorded least mean disease incidence of 30%. The diversity in incidence may be related to differences in varietal status, planting time, transplanting, soil type, fertilizer dosage and changes in weather conditions. Large-scale cultivation of susceptible varieties as monocrop continuously on the same field could increase the potential for the pathogen to remain in plant debris. The pathogen survives in soil and water in the form of sclerotia which remains viable for up to 3 years (Kumar et al., 2009) (3).

4. Conclusion
Survey on incidence and spread of rice sheath blight in major rice growing regions of Eastern Uttar Pradesh disclosed that disease is a major constrain of the zone. Among the five districts surveyed Jaunpur recorded highest mean of incidence 48.3% and followed by Varanasi, Prayagraj, Chandauli and comparatively low in Mirzapur (35%). The prevalence of sheath blight may be caused by the most favourable factors such as high relative humidity, lower temperature and water logging due to continuous rain at these locations during surveying. Large-scale cultivation of susceptible varieties as monocropping continuously in the same field could increase the potential for the pathogen to remain in plant debris. The current study may serve as a harbinger for developing an effective management strategy for the region in an integrated manner for sustainable crop development in the state.

5. References
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![Fig 1: Disease incidence of sheath blight in rice growing regions of eastern Uttar Pradesh during Kharif – 2019](image)

Table 1: Collection of sheath blight disease samples from major rice growing areas of Eastern Uttar Pradesh during Kharif-2019

| Isolates | Latitude/Longitude | Districts | Location | Rice variety | Crop stage | Plant parts collected | DI (%) | Severity (%) | SES (0-9) |
|----------|-------------------|-----------|----------|--------------|------------|-----------------------|--------|--------------|----------|
| RSV-1    | 25.10'44"N/82.58'51"E | Mirzapur  | Bakiabad | PNR-381      | Flowering  | Leaf                  | 40     | 21-30        | 3        |
| RSV-2    | 25.85'5"N/82.57'22"E | Mirzapur  | Kailahat | Type-9       | Heading    | Sheath & leaf         | 40     | 46-65        | 7        |
| RSV-3    | 25.73'8"N/82.54'53"E | Mirzapur  | Chunar   | 1509         | Flowering  | Sheath & leaf         | 45     | 46-65        | 7        |
| RSV-4    | 25.11'52"N/83.04'09"E | Mirzapur  | Narayanpur | Narennder-118 | Panicle initiation | Sheath | 20 | 21-30 | 3 |
| RSV-5    | 25.73'8"N/82.54'53"E | Mirzapur  | Jamalpur | Ganga kaveri | Heading    | Sheath                | 40     | 46-65        | 7        |
| RSV-6    | 25.59'5"N/82.52'0"E | Varanasi  | Maudli   | Type-9       | Panicle initiation | Leaf | 20 | 21-30 | 3 |
| RSV-7    | 25.16'9"N/82.54'9"E | Varanasi  | BHU      | Kasturi      | Milky stage | Sheath | 50 | 46-65 | 7 |
| RSV-8    | 25.20'19"N/82.59'38"E | Varanasi  | Khajuri   | Type 21      | Milky stage | Sheath & leaf | 40 | 46-65 | 7 |
| RSV-9    | 25.83'3"N/82.71'18"E | Varanasi  | Cholapur | Pusa Basmathi-1 | flowering | Sheath & leaf | 70 | 66-100 | 9 |
| RSV-10   | 25.15'49"N/83.81'7"E | Chandauli | Alinagar | Panth-4      | Tilling    | Sheath                | 30     | 21-30        | 3        |
| RSV-11   | 25.15'57"N/83.11'54"E | Chandauli | Ganga khaaja | Ganga kaveri | Panicle initiation | Sheath | 50 | 46-65 | 7 |
| RSV-12   | 25.15'16"N/83.12'12"E | Chandauli | Bichhiya khard | Swarn | Milky stage | Sheath | 25 | 31-45 | 5 |
| RSV-13   | 25.17'45"N/83.12'12"E | Chandauli | Sadalpura | Panth-12 | Heading      | Sheath & leaf | 80 | 66-100 | 9 |
| RSV-14   | 25.24'19"N/83.4'8"E | Chandauli | Dhara     | Kasturi      | Panicle initiation | Sheath | 30 | 31-45 | 5 |
| RSV-15   | 25.25'47"/81.81'56"E | Prayagraj | Dhanuha   | SHAUTS dhan-1 | Milky stage | Leaf | 40 | 46-65 | 7 |
| RSV-16   | 25.42'11"N/81.84'13"E | Prayagraj | SHUATS     | P Pant gold  | Heading      | Sheath & leaf | 60 | 46-65 | 7 |
| RSV-17   | 25.38'96"N/81.88'79"E | Prayagraj | Naini     | Panth-12    | Panicle initiation | Leaf | 70 | 66-100 | 9 |
| RSV-18   | 25.53'13"N/81.84'91"E | Prayagraj | Phaphamau | 1509 | Panicle initiation | Sheath | 30 | 31-45 | 5 |
| RSV-19   | 25.33'96"N/81.82'03"E | Prayagraj | Dandupur  | Panth-12    | Milky stage | Sheath & leaf | 25 | 31-45 | 5 |
| RSV-20   | 25.71'93"N/82.66'32"E | Jaunpur   | Meerganj  | Ganga kaveri | Panicle initiation | Leaf | 30 | 31-45 | 5 |
| RSV-21   | 25.71'63"N/82.62'32"E | Jaunpur   | Sadanpur  | Manhar      | Heading      | Sheath | 40 | 46-65 | 7 |
| RSV-22   | 25.73'98"N/82.66'05"E | Jaunpur   | Kalichabad | Panth-4 | Milky stage | Sheath & leaf | 50 | 46-65 | 7 |
| RSV-23   | 25.72'91"N/82.68'21"E | Jaunpur   | Wazidpur  | Basmathi-370 | Panicle initiation | Sheath | 35 | 21-30 | 3 |
| RSV-24   | 25.43'92"N/82.92'33"E | Jaunpur   | Ruarkala  | Sarju-52    | Heading      | Sheath & leaf | 60 | 46-65 | 7 |
| RSV-25   | 25.47'40"N/83.00'53"E | Jaunpur   | Sathara   | Type-5      | Panicle initiation | Leaf | 70 | 66-100 | 9 |
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