**Screening of sheath blight (*Rhizoctonia solani* Kuhn) resistance in rice cultivars in Madhya Pradesh**

**ABSTRACT**

Sheath blight of rice caused by *Rhizoctonia solani* Kuhn is a deadly disease causing heavy devastation to the crop under favourable environmental conditions. An experiment was conducted at experimental area of AICRP on rice, at College of Agriculture, Rewa (M.P.) during *Kharif* 2018. In the present study, ten cultivars of rice were screened against sheath blight under artificial inoculations. A significant variation in length of lesions and relative lesion height (RLH) was recorded in all the tested cultivars. At 35 days after transplanting (DAT), the Lesion length ranged from 1.0 (P 1509) to 2.7 cm (P 1121), at 45 DAT it ranged from 2.1 (Kalikamod) to 4.2 cm (P 1121) and 4.2 cm (Chinnor) and finally at 55 DAT it ranged from 2.3 (Kalikamod) to 5.4 cm (P 1121). At 35 DAT, the RLH ranged from 5.9 (JRB1) to 19.6% (P 1509), at 45 DAT it ranged from 11.7 (JRB1) to 34.9% (PS5), and finally at 55 DAT it ranged from 17.8 (JRB1) to 66% (P 1509) were recorded. Incubation period varied from 48 to 108 hrs with a mean of 74.4 hrs. The data on apparent infection rate varied from 0.010 to 0.0265 with a mean of 0.0198 percent per day and the values of AUDPC varied from 137.7 to 370.0 with a mean of 270.1 were recorded. Among the tested cultivars of rice, Kalikamod and JRB1 were found highly resistant against sheath blight due to important disease variables *viz*., low lesion length, higher incubation period, lower apparent infection rate and AUDPC values under congenial microclimate.Three cultivars namely Luchai black, Chinnor and Jeera Shankar were found moderately resistant whereas,cultivars PS4, P1121, PS5,PS3 and P1509 were found susceptible to sheath blight under artificial inoculations. The resistant sources identified in the present study can be utilized in rice breeding programme against sheath blight disease.

**Key words:** *Oryza sativa,* Sheath blight, AUDPC, Incubation period and Resistance

**INTRODUCTION**

Rice *(Oryza sativa* L.) is one of the most important staple food crop grown in different ecology contributes 40% of total food grain production in India. Productivity of rice can be increased by adopting the hybrid rice, integrated nutrient and pest management for combating the economic losses due to biotic stresses. In India, area 46.38 Mha with production 130.29 Mt and productivity 2809 kg/ha (Anon, 2022). Among the major production constraints of rice, sheath blight occurrence (*Rhizoctonia solani* Kuhn) is becoming a very destructive disease and causing heavy yield losses 25% (Suthin *et al.,* 2018 and Kumar *et al.,* 2009). During severe condition, the disease spread to upper parts of the plants, panicles and a total crop loss may be observed (Srinivas *et al.,* 2013).The natural infection of the sheath blight disease occurs at the seedling, tillering and booting stages of rice. Infection usually starts near the water line of rice plants in paddy fields. Lesion develops upward to the upper leaf sheaths and leaf blades. This symptom generally referred as “banded blight”. *Rhizoctonia solani* possess pale to dark brown rapidly growing mycelium with septum in the branch near the point of origin. It produces large number of globose, sclerotia which initially turn white, later turn brown to purplish brown. Growing resistant varieties is the cheapest and feasible way to manage any disease. Keeping these facts in view, the present study was undertaken to identify resistant sources of rice against sheath blight and disease variables responsible for disease development.

**MATERIALS AND METHODS**

The diseased leaf sheaths collected from previous crop season showing characteristic symptoms were thoroughly washed repeatedly in tape water. Thereafter, small bits measuring about 5 mm were cut for isolation. The sheath bits were surface sterilized with 0.1 per cent mercuric chloride (HgCl2) solution for 30 second followed by three change of sterilized water. The surface sterilized sheath bits were aseptically transferred to the petri plates containing potato dextrose agar (PDA) medium and incubated at 28±20 C. After 48 hours of incubation, the growing mycelium from the margin of apparently distinct colonies were sub cultured aseptically on fresh PDA plates and pure culture of *R. solani* was maintained. Temporary slides of the culture were prepared in lacto phenol cotton blue and examined under compound microscope for the mycelia characters for confirmation and identification of the fungus.

Ten rice cultivars were evaluated by using standard recommended package of practices for optimum plant growth in randomized block design in three replications at experimental area of AICRP on rice, at College of Agriculture, Rewa (M.P.) during *Kharif* 2018. Five plants in each replication were artificially inoculated with sclerotia by using clip method at 21 days after transplanting. Sclerotia were inserted between the stem of the middle tillers of each plant and leaf sheath of basal node. High humidity was maintained during disease development by frequent watering. The inoculated plants were observed daily for development of symptoms.Observations on lesion length (cm) and vertical disease spread in terms of relative lesion height (RLH) were recorded at 10 days interval in each cultivars till 55 DAT. The RLH (%) was calculated as per formula given by Ahn *et al.* (1986).

Total lesion length

RLH (%) = ------------------------------------------- x 100

Total length of sheath

The incubation period (days) was recorded from time of inoculation to the appearance of the disease symptoms in all the screened Rice cultivars. Apparent infection rate (r) was calculated using relative lesion height adopting the formula given by Vander Plank (1963).

1 X2

r = --------------- Loge ------------

t2 – t1  X1

Where ,

r is the apparent infection rate per day

t1 and t2 is the initial and final time for disease recorded

X1 and X2 are the proportions of lesion height at time t1 and t2, respectively.

 Area under Disease Progress Curve (AUDPC) was calculated using a simple midpoint formula as described by Madden *et al* (2007).

Where**,** “t” is time in days of each observation,

“y” is the percentage of lesion height at each reading

“n” is the number of observation.

The screened genotypes were grouped into different categories of reaction according to Standard Evaluation Scale (SES).

**List 1 : SES (0-9) for banded leaf and sheath blight of Rice. (IRRI, 1996)**

|  |  |  |
| --- | --- | --- |
| **Scale** | **Description** | **Host reaction** |
| 0 | No infection | Highly resistant (HR) |
| 1 | Vertical spread of the lesions up to 20% of plant height. | Resistant ( R) |
| 3 | Vertical spread of the lesions up to 21-30% of plant height. | Moderately resistant (MR) |
| 5 | Vertical spread of the lesions up to 31-45% of plant height. | Moderately susceptible (MS) |
| 7 | Vertical spread of the lesions up to 46-65% of plant height. | Susceptible (S) |
| 9 | Vertical spread of the lesions more than 65% of plant height. | Highly susceptible (HS) |

The values expressed in percentage were transformed to angular (arc-sin) values before analysis. The data were analyzed statistically using Randomized Block Design.

**RESULTS AND DISCUSSION**

Significant differences in lesion length (cm) were recorded in 10 cultivars of rice at 55 days after transplanting (Table 1). At 35 DAT, the Lesion length ranged from 1.0 (P1509) to 2.7 cm (P1121), at 45 DAT it ranged from 2.1 (Kalikamod) to 4.2 cm (P1121) and 4.2 cm (Chinnor) and finally at 55 DAT it ranged from 2.3 (Kalikamod) to 5.4 cm (P1121). The lowest progression of disease development at all dates of observation was recorded in Kalikamod followed by P1509, JRB1, Luchai black and Jeera shankar. Whereas, highest progression of disease development was observed P1121 followed by Chinnor, PS3, PS5 and PS4. Days to 50% flowering period varied from 84 to 110 days were recorded with lowest flowering period in JRB1 followed by PS4 (89 days) while, highest flowering period was recorded in Jeera shankar (110 days) followed by Kalikamod (109) and Chinnor (105 days) .

Ten cultivars of rice were evaluated in under artificial inoculated conditions *in-vivo* against sheath blight of rice. The disease development of sheath blight was recorded in terms of percent relative lesion height (RLH) at an interval of 10 days starting from the inoculation. Data pertaining to RLH (%) at 35, 45 and 55 days after transplanting are presented in table 2. At 35 DAT, the RLH ranged from 5.9 (JRB1) to 19.6% (P1509), at 45 DAT it ranged from 11.7 (JRB1) to 34.9% (PS5) and finally at 55 DAT it ranged from 17.8 (JRB1) to 66% (P 1509). The lowest progression of disease development at all dates of observation was recorded in JRB1 followed by Kalikamod, Luchai black, Jeera Shankar and Chinnor. Whereas, highest progression of disease development was observed P1509 followed by P1121, PS5, PS3 and PS4

Incubation period, apparent infection rate (r) and area under disease progress curve (AUDPC) were calculated in tested cultivars of Rice and data are presented in Table 3. Incubation period (hrs) is the time period between inoculation and disease appearance recorded in rice cultivars. Incubation period varied from 48 hrs to 108 hrs days were recorded with lowest Incubation period in PS5 and P1121 followed by PS4 (60 hrs), PS3 (66 hrs) and P1509 (72 hrs), while highest Incubation period was recorded in JRB1(108 hrs) followed by Kalikamod (96 hrs), Luchai black (86 hrs), Chinnor (84 hrs) and Jeera shankar (78 hrs).The mean apparent infection rate (r) at the exponential growth stage ranged 0.017 to 0.021 between 35 to 45 and 45 to 55 DAT. Mean apparent infection rate was maximum between 35 to 45 DAT indicates the favourable period for disease development. Minimum mean infection rate was recorded between 45 to 55 DAS indicates the less favourable conditions for disease development. Apparent infection rate (percent per day) was maximum in Kalikamod (0.033) and PS5 (0.033) followed by JRB1 (0.029), P1121 (0.024), Luchai black (0.023), P1509 (0.020) and Jeera Shankar (0.020) whereas, minimum was in Chinnor (0.003) followed by PS4 (0.015) and PS-3 (0.018) between 35 to 45 DAT. Variation in apparent infection rate was between 45 to 55 days was 0.004 to 0.032. Maximum apparent infection rate was observed in P1509 (0.032) followed by PS3 (0.028), P1121 (0.024), PS4 (0.022) and PS5 (0.020) whereas, minimum was in Kalikamod (0.004) followed by JRB1 (0.005), Jeera Shankar (0.008), Luchai black (0.014) and Chinnor (0.017). Average apparent infection rate of consecutive observation period ranged from 0.010 to 0.026 percent per day. Lowest apparent infection was recorded in Chinnor (0.010) followed by Jeera Shankar (0.014), JRB1 (0.017), Luchai black (0.018) and Kalikamod (0.018) Whereas, highest values were recorded in P1509 (0.026) and PS5 (0.026) followed P1121 (0.024), PS3 (0.023) and PS4 (0.021). In general, lower values of apparent infection rate was recorded in resistant and moderately resistant cultivars and higher values were recorded in susceptible cultivars. The AUDPC ranged between137.7 to 370.0 on different rice cultivars, minimum being in JRB-1(137.7) followed by Kalikamod (161), Luchai black (189.5), Jeera Shankar (217.2) and Chinnor (218.2). However, it was maximum in P1509 (370) followed P1121 (368.2), PS4 (358.5), PS5 (353.7) and PS3 (326.7). Based on the observations, cultivars showing lower AUDPC values may be considered as slow blighting cultivars.

Based on the vertical spread of the disease in terms of RLH (%), tested cultivars of rice were grouped into different categories of resistance/ susceptibility and data are presented in table 4. None of the evaluated cultivars were highly resistant to sheath blight. Two cultivars namely Kalikamod and JRB1 were found resistant against sheath blight. Three cultivars namely Luchai black, Chinnor and Jeera Shankar were moderately resistant, None of the evaluated cultivars were moderately susceptible and 5 cultivars namely PS4, P1121, PS5, PS3 and P1509 were susceptible to sheath blight showing more than 45% vertical spread of the disease. The findings were also supported by Adhipathi *et al.* (2013), Bhukal *et al.* (2015), Chandra *et al.* (2016) and Tejaswani *et al.* (2016) who also screened the rice cultivars against sheath blight and very few cultivars were found resistant to sheath blight under natural conditions. Willocquet *et al.* (2011) reported that maximum lesion length and vertical sheath colonization were main components of resistance measured with respect of physiological resistance to rice sheath blight. Hossain *et al.* (2014) also observed significant correlations among diseased plant affected area, visual rating (VRT) and relative lesion height with VRT being the most accurate in rice against *R. solani*. Kahar (2017) in kodo millet and Kumar (2018) in little millet were also reported that low values of apparent infection rate as well as AUDPC and higher incubation period contributed towards resistance and for identification of slow blighting genotypes against *R. solani* causing banded leaf and sheath blight.

**CONCLUSION:**

It may be concluded that two cultivars of rice namely Kalikamod and JRB1 were found resistant against sheath blight. Low lesion length, less than 20% RLH, higher incubation period, lower apparent infection rate and AUDPC values were recorded in these cultivars. These disease variables significantly contributed in resistance. Three cultivars namely Luchai black, Chinnor and Jeera Shankar were moderately resistant, none of the evaluated cultivars were moderately susceptible and 5 cultivars namely PS4, P1121, PS5, PS3 and P1509 were susceptible to sheath blight with higher lesion length, RLH, higher apparent infection rate, higher values of AUDPC and lower incubation period.

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**Table -1. Lesion length (cm) at different days after transplanting in rice cultivars**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| S. No. | Cultivars | Days to flowering | Lesion length (cm) | | |
| 35 DAT | 45 DAT | 55 DAT |
| 1 | Kalikamod | 109 | 1.4 | 2.1 | 2.3 |
| 2 | Luchai black | 100 | 1.5 | 3.2 | 3.3 |
| 3 | JRB1 | 84 | 1.4 | 2.9 | 3.0 |
| 4 | Chinnor | 105 | 2.2 | 4.2 | 4.4 |
| 5 | Jeera Shankar | 110 | 1.6 | 3.3 | 3.4 |
| 6 | PS4 | 89 | 1.9 | 2.7 | 4.1 |
| 7 | P1121 | 92 | 2.7 | 4.2 | 5.4 |
| 8 | PS5 | 92 | 1.6 | 2.9 | 4.1 |
| 9 | PS3 | 90 | 1.9 | 3.9 | 4.4 |
| 10 | P1509 | 93 | 1.0 | 2.2 | 2.6 |
|  | **CD (5%)** | **5.112** | **0.795** | **0.026** | **0.032** |

**Table-2. Relative lesion height (%) at different days after transplanting in rice cultivars**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| S. No. | Cultivars | Relative lesion height (%) | | | | | |
| 35 DAT | | 45 DAT | | 55 DAT | |
| Original values | Transformed values | Original values | Transformed values | Original values | Transformed values |
| 1 | Kalikamod | 8.3 | 15.237 | 18.1 | 25.115 | 19.9 | 26.494 |
| 2 | Luchai black | 11.1 | 19.339 | 19.7 | 25.901 | 26.5 | 30.979 |
| 3 | JRB1 | 5.9 | 14.079 | 11.7 | 19.989 | 17.8 | 24.926 |
| 4 | Chinnor | 18.3 | 25.316 | 19.8 | 27.119 | 29.4 | 32.816 |
| 5 | Jeera Shankar | 14.3 | 22.178 | 22.7 | 28.450 | 27.4 | 31.545 |
| 6 | PS4 | 19.2 | 25.976 | 31.1 | 33.920 | 52.5 | 46.435 |
| 7 | P1121 | 18.7 | 25.580 | 32.9 | 35.025 | 57.9 | 49.315 |
| 8 | PS5 | 16.1 | 23.624 | 34.9 | 36.195 | 55.6 | 48.196 |
| 9 | PS3 | 18.7 | 25.580 | 28.6 | 32.311 | 54.8 | 47.773 |
| 10 | P1509 | 19.6 | 26.263 | 31.3 | 34.018 | 66.0 | 54.311 |
|  | **CD (5%)** |  | **2.111** |  | **2.081** |  | **1.946** |
|  | **CV (%)** |  | **5.5** |  | **4.03** |  | **2.9** |

**Table-3. Incubation period, apparent infection rate and area under disease progress curve in rice cultivars**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| S. No. | Cultivars | Incubation period  (hrs) | Apparent infection rate (r) | | | AUDPC | Reaction |
| 35 – 45 DAT | 45 – 55 DAT | Mean |
| 1 | Kalikamod | 96 | 0.033 | 0.004 | 0.0185 | 161.0 | R |
| 2 | Luchai black | 86 | 0.023 | 0.014 | 0.0185 | 189.5 | MR |
| 3 | JRB1 | 108 | 0.029 | 0.005 | 0.0170 | 137.7 | R |
| 4 | Chinnor | 84 | 0.003 | 0.017 | 0.0100 | 218.2 | MR |
| 5 | Jeera Shankar | 78 | 0.020 | 0.008 | 0.0140 | 217.7 | MR |
| 6 | PS4 | 60 | 0.015 | 0.022 | 0.0210 | 358.5 | S |
| 7 | P1121 | 48 | 0.024 | 0.024 | 0.0240 | 368.2 | S |
| 8 | PS5 | 48 | 0.033 | 0.020 | 0.0265 | 353.7 | S |
| 9 | PS3 | 66 | 0.018 | 0.028 | 0.0230 | 326.7 | S |
| 10 | P1509 | 72 | 0.020 | 0.032 | 0.0260 | 370.0 | S |
|  | **MEAN** | **74.4** | **0.021** | **0.017** | **0.0198** | **270.1** |  |

**Table 4. Grouping of rice cultivars against sheath blight disease**

|  |  |  |  |
| --- | --- | --- | --- |
| Reaction | SB severity (RLH %) | No. of cultivars | Cultivars |
| Highly resistant | 0 | 0 | Nil |
| Resistant | Up to 20 | 2 | Kalikamod, JRB1 |
| Moderately resistant | 20 – 30 | 3 | Luchai black, Chinnor, Jeera Shankar |
| Moderately susceptible | 31 -45 | 0 | Nil |
| Susceptible | 46-65 | 5 | PS4, P1121, PS5, PS3, P1509 |
| Highly susceptible | Above 65 | 0 | Nil |