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Progression and Development of little millet banded leaf and sheath blight caused by *Rhizoctonia solani* Kuhn in relation to weather variables

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ABSTRACT

Banded leaf and sheath blight (BLSB) caused by Rhizoctonia solani Kuhn is an emerging disease and becoming a serious problem in little millet (Panicum sumatrense) cultivation at all the stages of crop growth. In the present study, progression and development of BLSB was studied at 20, 30, 40 and 50 days old crop artificially inoculated with R. solani. Significant linear increase in relative lesion height (RLH) was recorded at all the crop age. Average incubation period was recorded 2.7 days in 20 days old, 5.4 days in 30 days old, 6.2 days in 40 days old and 6.6 days in 50 days old inoculated crop. The values of area under disease progress curve were 178.7, 186.6, 163.4 and 145.6 in 20, 30, 40 and 50 days old inoculated crops, respectively. It indicates that progression and development of BLSB was maximum in 20 days and 30 days old crops. Significant positive correlation of RLH with total rainy days (r= 0.973) andminimum temperature (r= 0.975*) was found. Total rainfall with rainy days (r= 0.967*) and minimum temperature (r= 0.960*) were found positively correlated. Significant positive correlation between rainy days and minimum temperature (r= 0.997*) was also observed. It suggests that total rainy days, rainfall and minimum temperature played major role in the development of disease in little millet.*

Key words: *Little millet, banded leaf and sheath blight, Rhizoctonia solani, progression and development, weather variables*

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INTRODUCTION

Little millet (*Panicum sumatrense*), native to India is a hardy small seeded cereal crop belonging to family Poaceae (Gramineae) generally grown by socio-economically poor farmers with low inputs in low fertile lands. It is suitable for fragile and vulnerable ecosystems climate wise and regarded as preferred crop for sustainable and green agriculture. In India, the crop is grown in an area of 291 thousand hectares with annual production of 102 thousand tones and 349 kg ha^{-1} productivity. Madhya Pradesh ranks second in area of little millet after kodomillet, where the crop is cultivated in 42.68 thousand hectares with average yield of 520 kg ha^{-1}(www.landrecords.mp.gov.in). Little millet is an annual herbaceous plant, consumed as rice and the green plant can also be used in part as cattle feed. The crop is tolerant to drought as well as water logging conditions and can give assured harvest in extreme adverse climatic conditions. The grains of little millet are rich in fiber, protein, minerals and has low glycemic index, which helps to

manage diabetes, blood pressure, constipation and obesity [12] *Rhizoctonia solani* (telomorph;*Thanatephorus cucumeris*) is reported to cause severe banded leaf and sheath blight (BLSB) disease in cereals as well as little millet [6, 10, 13]. In a field survey, banded leaf and sheath blight incidence in little millet was reported ranging from 6.9 to 18.8% with 26.1 to 75.4% frequency of occurrence in five districts of Madhya Pradesh during 2012-13 to 2016-17 by Jain *et al* [5]. Retarding effect in agro-morphological characters and 17.8% reduction in grain yield per plant were reported by Chouhan [3] in little millet. Literature about the progression and development of BLSB in little millet is scanty. Hence, the present investigationwas undertaken to study the progression and development of little millet banded leaf and sheath blight in relation to weather variables.

MATERIAL AND METHODS

Seeds of nineteen pre-release and released cultivars of little millet were sown in two rows of 3.0 m length with row to row 22.5 cm and plant to plant 7.5 cm spacing in randomized block design with three replication during *Kharif* 2017. Recommended doses of fertilizers i.e. 40:20:0 kg NPK per ha were applied for optimum plant growth. Ten plants of each cultivar from each replication were artificially inoculated at 20, 30 40 and 50 days old crop by leaf bit method. Infected leaf bits of about 1 to 2 cm long were inserted between the stem of the middle tiller 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. The incubation period (days) was recorded from time of inoculation to the appearance of the disease in all the screened little millet cultivars. Observations on vertical disease spread in terms of relative lesion height (RLH) were recorded at 10 days interval as per formula given by Ahn *et al*, [1].

$$\text{RLH (\%)} = \frac{\text{Total lesion length}}{\text{Total length of sheath}} \times 100$$

Area under Disease Progress Curve (AUDPC) was calculated on progression of disease at different crop stages using a simple midpoint formula as described by Madden *et al* [8].

$$\text{AUDPC} = \sum_{i=1}^{n-1}\left(\frac{y_i + y_{i+1}}{2}\right)\left(t_{i+1} - t_i\right)$$

Where, "t" is time in days of each observation,
"y" is the percentage of lesion length at each reading
"n" is the number of observation.

Observations on weather parameters namely rainy days, rainfall (mm), maximum & minimum temperature and relative humidity (%) were recorded during disease development phase. The progression of the disease was analysed with prevailing weather variables such as rainfall (RF), rainy days, maximum and minimum temperature (Tmax and Tmin) and relative humidity (RH). The correlation coefficients were calculated by using software WASP-1. The data of RLH (%) was transformed before statistical analysis.

RESULTS AND DISCUSSION

Development of banded leaf and sheath blight (BLSB) in terms of relative lesion height (RLH %) and values of AUDPC in evaluated little millet cultivars inoculated at 20, 30, 40 and 50 days old crops are presented in table 1. Significant differences in RLH were recorded at different crop ages.

Crop age on development of BLSB

RLH (%) ranging from 27.1 to74.8%, 28.2 to 77.8%, 26.7 to 48.5% and 22.1 to 37.9% were recorded at 20, 30, 40 and 50 days old crops, respectively. Average value of RLH was 27.2 to 59.8% with a mean of 37.9%in evaluated cultivars. Minimum RLH (%) was recorded in GPUL 4 followed by BL 6 (27.7%) and JK 36 (28.2%), where as maximum RLH (%) was recorded in WV 167 followed by WV 125 (44.1%), OLM 203 (41.7%) and IIMR LM 7012 (41.0%). Linear decrease in average RLH was recorded from 43.0,41.3, 37.2 and 29.9% in little millet cultivars inoculated at 20,30,40 and 50days old crop, respectively. The value of

AUDPC varied from 107.4 to 279.0 was minimum in GPUL 4 followed by BL 6 (108.1) and maximum in WV 167 followed by WV 125 (230.4).

The values of AUDPC, ranging from 107.4 to 279.0 were recorded in 19 cultivars of little millet inoculated at 20 DAS. Lowest values were recorded in GPUL 4 and BL 6 and highest values In WV 167 and WV 125.The values of AUDPC ranged from 126.6 to 297.5 in little millet cultivars inoculated at 30 DAS. Lowest values of AUDPC were recorded in BL 6, JK 36 and GPUL 4 and highest in WV 167 and WV 125. The AUDPC values ranging from 108.4 to 213.5 was minimum in JK 8 followed by BL 6 (115.6) and JK 36 (116.3) and maximum in TNPSu 186 (213.5) followed by RLM 37 (203.1) and WV 167 (199.5) in little millet cultivars inoculated at 40 DAS. The values of AUDPC varied from 86.7 to 186.3 were minimum in GPUL 4 and maximum in WV 126 in little millet cultivars inoculated at 50 DAS. Average values of AUDPC ranged from 115.5 to 236.0 with a mean of 168.6 in 19 cultivars of little millet. Lowest value was recorded in BL 6 followed by GPUL 4 (117.9) and JK 36 (123.1), where as highest value was recorded in WV 167 followed by WV 125 (201.6).

Incubation period (days) was recorded 2.7, 5.4, 6.2 and 6.6 days in little millet crop inoculated at the age of 20, 30, 40 and 50 days, respectively. Lowest incubation period was recorded in artificial inoculation at 20 days old crop, which gradually increased at old age crop inoculations. Maximum incubation period (6.6 days) was recorded in 50 days old crop. Disease development phase was 15th August to 30th September, 2017 in 20 days old crops , where as it was 25th August to 30th September, 2017, 5th September to 30th September and 15th September to 30 September, 2017 in 30, 40 and 50 days old little millet crop. Progression and development of BLSB was maximum in 20 days and 30 days old crops. This gradually decreased in 40 and 50 days old crops. It indicates that 20 and 30 days old crops are more prone to BLSB compared to 40 and 50 days old crops(Table 2, Fig. 1 & 2) .Thind *et al* [15] also reported crop age as an important factor in sheath blight development and tillering to panicle emergence stage were the most susceptible to *R. solani.* The similar results were also reported by [14] in rice.

Weather parameters on development of BLSB

Weather parameters such as total rainfall (mm), rainy days, maximum temperature (Tmax) , minimum temperature (Tmin) , mean temperature and maximum relative humidity were recorded in disease development phase at different crop age and data are presented in table 3. The data revealed that at 20 days crop age, total rainfall was 160.2 mm, rainy days were 9, Tmax. Was 33.67^{0}C, Tmin. was 23.2^{0}C, mean temperature was 28.44^{0}C and maximum RH was 78.7% during disease development phase (15th August to 30th September, 2017). At 30 days crop age total rainfall was 96.6 mm, rainy days were 7, Tmax was 33.68^{0}C, T min was 22.92^{0}C, mean temperature was 28.30^{0}C and maximum RH was 78.6% during disease development phase (25th August to 30th September, 2017). During disease development phase of 40 days old crop, total rainfall was 94.4 mm, rainy days were 6, Tmax was 34.2^{0}C, Tmin was 22.73^{0}C, mean temperature was 28.38^{0}C and maximum RH was 78.1%. In 50 days old inoculated crop, weather variable such as total rainfall was 49.2 mm, rainy days were 3, Tmax was 33.51^{0}C, Tmin was 22.39^{0}C, mean temperature was 27.95^{0}C and maximum RH was 79.1% during disease development phase (15th September to 30 September , 2017). Average RLH (%) was 43.0%, 41.3%, 37.2% and 29.9% on 30th September, 2017 in 20, 30, 40 and 50 days old inoculated crops, respectively. It indicates that total rainfall and rainy days favours the BLSB incidence.

Correlation coefficients were calculated for the progression of BLSB in relation to weather parameters and data are presented in table 4. The disease severity (RLH) had significant positive correlation with rainy days (r = 0.973*) and minimum temperature (r = 0.975*). Total rainfall (r = 0.0884) and mean temperature (r = 0.888) had positive but non-significant correlation with RLH. Non- significant negative correlation of maximum RH (r = -0.862) with RLH was observed. Significant positive correlations between total rainfall and rainy days (r = 0.967*), total rainfall with minimum temperature (r = 0.960*), rainy days with minimum temperature (r = 0.997*) were recorded. Significant negative correlation between mean temperature and maximum RH (r = - 0.991*) was observed. Other correlations were either positive or negative but non-significant. Correlation coefficient measures the severity strength of the linear relationship between two variables. The data revealed that total rainfall and rainy days contributed more in progression and development of BLSB in little millet. Findings of earlier reports are in close proximity with the present finding. Positive

correlation between sheath blight incidence and minimum temperature was reported by Yuno *et al* [16] and Mathai *et al* [9] in rice. Lenka *et al* [7] reported that maximum and minimum temperature and evaporation rate contributed 9.03, 23.03 and 61.05%, respectively for sheath blight incidence in rice . Dutta and Kalha [4] reported that high and frequent rains with moderate temperature (up to 30^0C) coupled with high relative humidity (79%) favours the spread of sheath blight in rice. Bhukal et al. [2] studied the role of weather parameter in the progression and development of the sheath blight of rice and revealed that maximum temperature (Tmax) range 31^0C to 33^0C, minimum temperature (Tmin) range 16^0C to 25^0C and relative humidity more than 90% played major role in the progression of the disease. The regression equation developed indicates that Tmin played major role in the development of the sheath blight in rice. Pal *et al* [11] reported that heavy rainfall is conducive for initiation of sheath blight in rice. A maximum temperature range of 31 to 34^0C, min. temperature range of 17 to 23^0C with 70 to 73% evening RH were favourable for disease development and spread.

Table 1. Relative lesion height (%) and AUDPC values of banded leaf and sheath blight in 19 little millet cultivars inoculated at different crop age.

S. No.	Entry	Average relative lesion height (%)					AUDPC values				
		20 days	30 days	40 days	50 days	Mean	20 days	30 days	40 days	50 days	Mean
1	DLM 95	35.1 (36.25)	43.7 (41.39)	34.3 (35.77)	31.6 (23.13)	36.2	149.3	211.9	153.1	167.4	170.4
2	WV 126	49.7 (44.85)	44.4 (41.77)	32.3 (34.58)	35.8 (36.26)	40.6	219.6	228.1	136.7	186.3	192.7
3	DHLT 28-4	38.8 (38.49)	37.4 (37.69)	33.3 (35.17)	30.0 (33.91)	34.9	179.0	161.7	147.1	134.9	155.7
4	OLM 217	43.1 (40.97)	32.9 (34.96)	34.6 (35.96)	29.5 (32.07)	35.0	185.2	155.1	156.7	137.8	158.7
5	WV 167	74.8 (60.11)	77.8 (62.25)	48.5 (44.15)	37.9 (38.80)	59.8	279.0	297.5	199.5	167.9	236.0
6	IIMR LM 7012	50.3 (45.16)	44.0 (41.52)	40.5 (39.51)	29.3 (37.77)	41.0	197.5	207.2	189.3	131.8	181.5
7	OLM 233	51.0 (45.56)	34.5 (35.96)	44.4 (41.75)	32.7 (32.94)	40.7	193.8	152.4	172.9	160.5	169.9
8	IIMR LM 7162	52.2 (46.26)	38.5 (38.33)	40.7 (39.62)	31.6 (30.83)	40.8	195.1	201.6	173.7	155.0	181.4
9	TNPSu 183	41.3 (39.95)	44.4 (41.79)	33.3 (35.21)	34.8 (38.83)	38.5	138.9	181.9	182.4	165.1	167.1
10	GPUL 4	28.2 (31.73)	29.9 (33.15)	28.6 (32.27)	22.1 (29.52)	27.2	107.4	141.7	135.7	86.7	117.9
11	TNPSu 186	46.6 (43.06)	39.0 (38.63)	44.8 (41.99)	33.3 (33.82)	40.9	194.9	163.4	213.5	154.1	181.5
12	GPUL 5	39.1 (45.91)	43.3 (41.16)	37.9 (37.97)	29.1 (34.51)	37.4	192.9	206.4	189.5	164.0	188.2
13	WV 125	51.6 (38.70)	56.9 (49.00)	42.2 (40.49)	25.8 (29.35)	44.1	230.4	260.0	196.3	119.8	201.6
14	RLM 37	37.1 (37.49)	41.1 (39.88)	40.5 (39.46)	32.4 (35.00)	37.8	167.6	174.6	203.1	167.3	178.2
15	RLM 367	36.3 (37.03)	40.2 (39.35)	33.3 (35.19)	31.7 (33.36)	35.4	150.0	189.2	130.3	141.9	152.9
16	JK 8	39.9 (39.17)	36.7 (37.26)	36.0 (36.84)	26.7 (32.01)	34.8	197.8	156.8	108.4	129.4	148.1
17	OLM 203	45.0 (41.11)	42.5 (40.59)	45.7 (42.52)	33.6 (33.83)	41.7	175.5	193.8	184.6	178.3	183.1
18	BL 6	27.1 (31.34)	28.2 (32.08)	26.7 (31.09)	28.8 (33.60)	27.7	108.1	126.6	115.6	111.6	115.5
19	JK 36	29.9 (33.11)	28.9 (32.49)	28.6 (32.29)	25.5 (30.48)	28.2	133.1	136.0	116.3	106.9	123.1
	Mean	43.0	41.3	37.2	29.9	37.9	178.7	186.6	163.4	145.6	168.6
	CD (P=0.05)	8.428	4.534	6.064	NS		-	-	-	-	-

*Figures in parentheses are ARC SIN transformed values

It may be concluded from the present study that progression and development of BLSB was maximum in 20 days and 30 days old crops. Maximum RLH (%) was recorded during disease development phase from 15th August to 30th September, 2017 (43.0%) in 20 days

old crop. Whereas minimum RLH (29.9%) was recorded during disease development phase (15th September to 30th September, 2017) of 50 days old inoculated crop. Lowest incubation period (2.7 days) was recorded in 20 days old inoculated plant. Total rainy days (r= 0.973*) and minimum temperature (r= 0.975*) were found positively correlated with relative lesion height and significantly contributed more in banded leaf and sheath blight development in little millet.

Table 2 Incubation period, average RLH and AUDPC values of BLSB at different crop age of little millet

Crop age (days)	Disease development phase	Incubation period (days)	Average RLH (%)	AUDPC
20	15 Aug. to 30 Sept.	2.7	43.0	178.7
30	25 Aug. to 30 Sept.	5.4	41.3	186.6
40	05 Sept. to 30 Sept.	6.2	37.2	163.4
50	15 Sept. to 30 Sept.	6.6	29.9	145.6

Table 3. Weather parameters during disease development phase at different crop age in little millet.

Crop age (days)	Disease development phase	Weather parameters					
		Total rainfall	Rainy days	Max. Temp.	Min. Temp.	Mean Temp.	Max. RH
20	15 Aug. to 30 Sept., 2017	160.2	9	33.67	23.2	28.44	78.7
30	25 Aug. to 30 Sept., 2017	96.6	7	33.68	22.92	28.30	78.6
40	05 Sept. to 30 Sept., 2017	94.4	6	34.02	22.73	28.38	78.1
50	15 Sept. to 30 Sept., 2017	49.2	3	33.51	22.39	27.95	79.1

Table 4. Correlation coefficient (r) among weather parameters and relative lesion height of BLSB

-	X_1	X_2	X_3	X_4	X_5	X_6	X_7
X_1	1.000	0.884	0.973*	0.263	0.975*	0.888	-0.862
X_2		1.000	0.967*	0.200	0.960*	0.854	-0.800
X_3			1.000	0.273	0.997*	0.915	-0.872
X_4				1.000	0.180	0.649	-0.708
X_5					1.000	0.874	-0.826
X_6						1.000	-0.991*
X_7							1.000

*Significant at 5% level

X_1= Relative lesion height (%) , X_2= Rainfall , X_3= Rainy days , X_4= Maximum temperature , X_5= Minimum temperature , X_6= Average temperature , X_7= Relative humidity

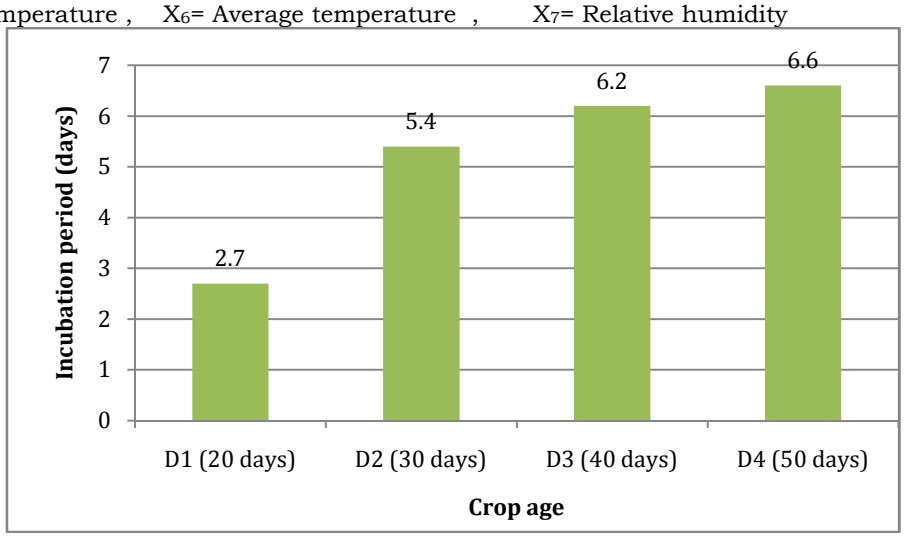

Fig. 1.Average incubation period in little millet cultivars artificially inoculated at different crop age.

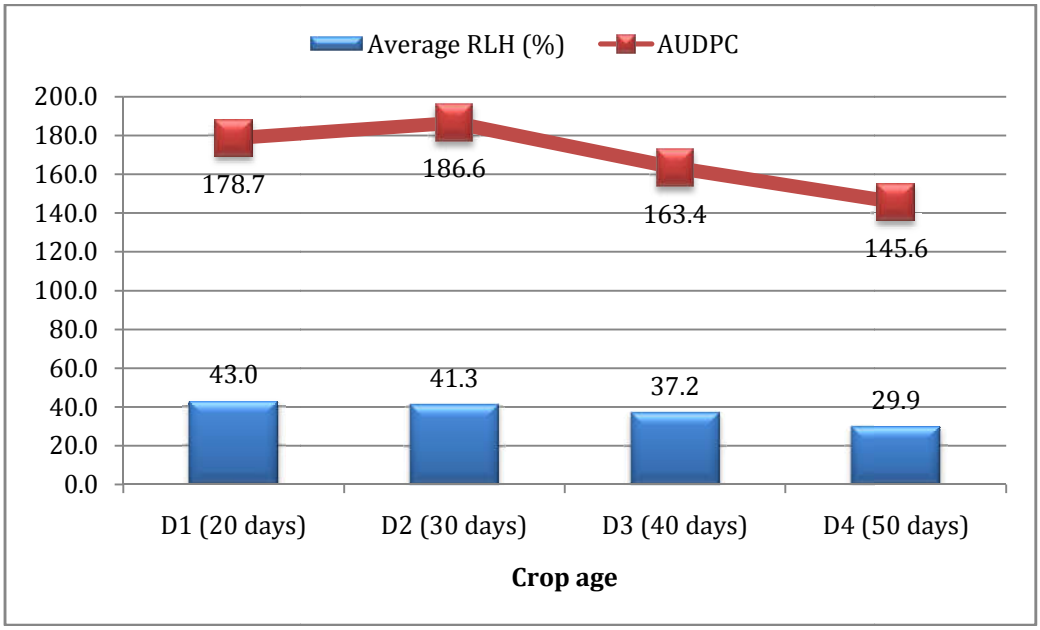

Fig.2. Average relative lesion height and AUDPC in little millet cultivars artificially inoculated at different crop age.

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